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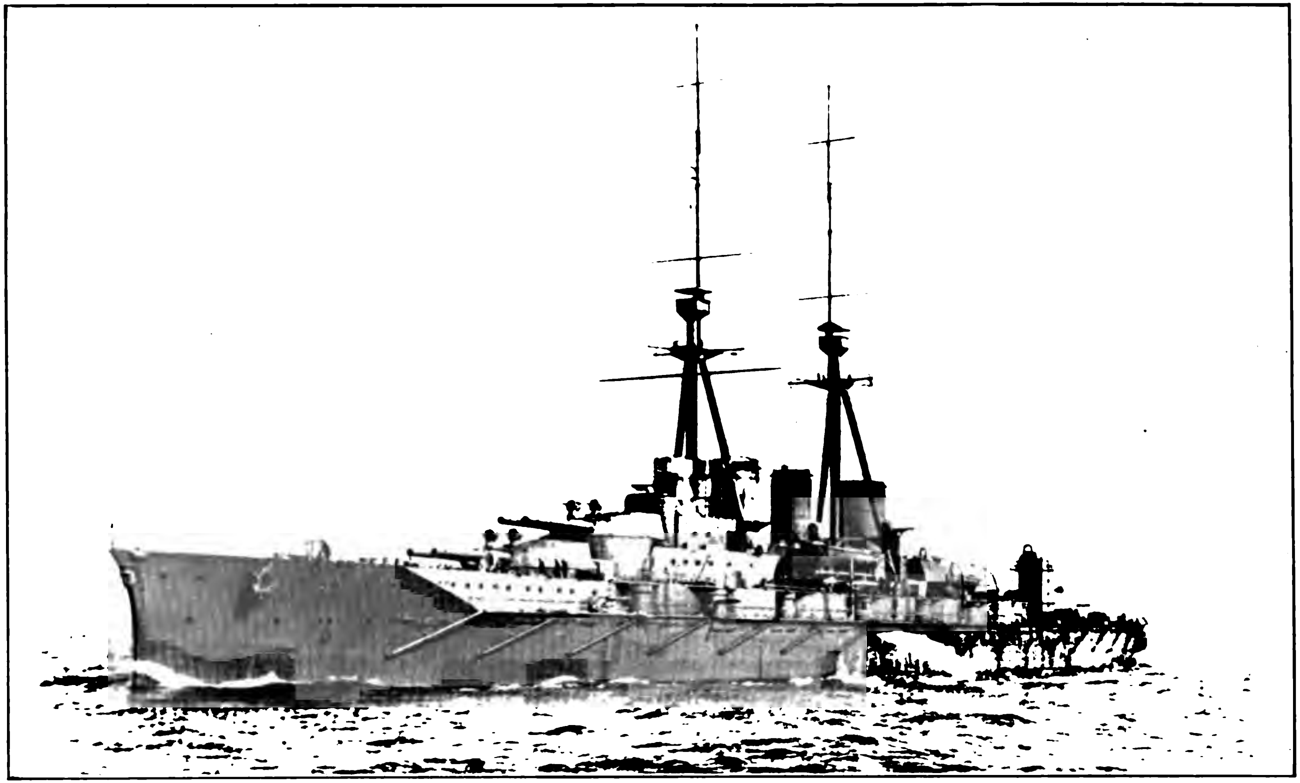

Photograph by Stephen Cribb, Southsea. 1386

THE JAPANESE BATTLE-CRUISER KONGO

Displacement, 27,500 tons. Length, 704 feet. Beam, 92 feet. Maximum draught, 29½ feet. Armament: 8 14-inch, 45 cal.; 16 6-inch, 50 cal.; 16 14-pdr.; 8 21-inch torpedo tubes, submerged. Turbine, designed horse-power 68,000. Speed, designed, 27 knots.—Jane

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MILITARY CHARACTER*

By Colonel HENRY C. DAVIS, Coast Artillery Corps

All actions in war are influenced by physical,
mental and moral qualities of men.
Bernhardi.

In much of this discussion the terms superior, leader, commander, etc., are used and qualifications are ascribed to them as necessary or desirable, apparently to the exclusion of subordinates; but this exclusion is only apparent, for every military person commands some one, if only himself, and he will do well to follow the correct course in leadership in leading himself.

In the treatment of this subject, the first step is necessarily a thorough understanding of what is meant by character in the general, and what in the special, sense as used in the question propounded.

The different senses in which the word character is used are classified in the *Century Dictionary* under twelve heads:

---

* A paper prepared at the 1913 Summer Conference of the Naval War College, Newport, R. I., and by request read to the members of the Conference and to the members of the class of officers of the Atlantic Fleet.

The subject in full as proposed was: "Discuss the qualities of military character, the means of their development and the method of their employment. Discuss the relations of loyalty, initiative, and the spirit of cooperation to naval efficiency. Explain in detail your view of, and suggest methods for improving the present military character of our service."—*The Editor.*

"1. A mark made by cutting * * * or engraving, as on * * * hard material; hence, a mark or figure, * * * used to communicate thought, * * *; a * * * sign." The word is probably derived from the Greek χαρακτηρ, an instrument for marking or graving on a hard substance, which came, in time, to signify the result produced by the tool; i.e., the mark or sign. This definition has little bearing directly on the subject under discussion, except so far as indicative of labor in forming the character, or sign; and, because of the material on which the operation is performed, the relative permanence of the result. This idea must pervade any discussion of character as formed or of the process of formation. Incidentally, in the cutting of this sign on a hard material, there exists a further analogy to the formation of character as here discussed, in that a slip of the tool in graving the sign and an error in the process of forming a character will mar the material and perhaps prevent a perfect result.

"5. The combination of properties, qualities * * * which distinguishes one person * * * from others; specifically, the sum of the inherited and acquired ethical traits which give to a person his moral individuality."

"6. The moral qualities assigned to a person by repute * * *."

"7. * * * good reputation: as, a man of worth and *character*.

"12. A person of marked peculiarities; * * * as, he was a character."

From these, it is seen that character is synonymous with a person's entity: the ego of a man. Also that it is recognized that character is dependent on heredity and acquirement. The one, the work of nature; and the other, that of the individual. The first may be called the potential character, or the basis of the latter. For this the individual has no responsibility, the good or bad thereof must be charged to his ancestors. But the latter, the acquired character, is one's own concern. The foundation may be good or bad and the opportunities for acquirement favorable or otherwise, but the result is chargeable to the individual.

A difference must be recognized in the estimation of character as between the credit awarded the individual for building it up and the worth or value of the character considered in relation to that of other individuals. In short, the actual value alone is of final importance in this discussion. An individual may attract our sympathy in his manful struggle in character building under unfavorable circumstances or our admiration or condemnation for a certain degree of success, accordingly as conditions were more or less favorable. But that is foreign to this subject, except so far as relates to assistance that may be afforded the individual and opportunities that may be offered him.

In defining more definitely what is meant by character, four divisions are recognized:

(a) Religious: not here considered.

(b) Moral: pertaining to the feelings; to the sentimental side of the individual as opposed to operations of the mind; involuntary or subconscious qualities as opposed to such as result from calculated mental action; qualities of heredity rather than of training, but still so largely affected by the latter that the fact must be recognized in any scheme of character building.

(c) Mental: the converse of moral in depending so largely on training; qualities that may be put down as subjects for acquisition.

(d) Physical: pertaining wholly to the man animal.

The distinction between moral and mental character is largely arbitrary.

The moral qualifications in a good military character are tested, in general, by an application of commonly recognized rules, and are the same as should be found in a good character of any type. They are necessary in the military character to the same extent as in others, perhaps even to a greater degree, for the military reputation must be clean. The standard is not exact and good moral character lies in quite a zone. Qualifications in this zone are, because of modern requirements, a common asset and have no weight in the comparative estimate. Those elevated above the standard are, however, a potential factor in creation of a character of worth.

Some of the qualifications that raise a character above the normal are unselfishness, consideration for others, a sense of justice and probity, self-appreciation, determination, etc. These are largely dependent on heredity, but may unquestionably be improved or allowed to decay.

Mental balance is related to the mental qualities, but is placed with the moral because of its general function as governor to the moral machine. Generosity and consideration for others may readily be carried to the extreme, resulting in the appearance of weakness, while excessive self appreciation may degenerate into self-assurance or even into arrogance. Mental balance must check both these and other like tendencies. In short, it is the quality that enables the individual so to train and martial his internal forces as best to fulfil his mission in character making. To command others, the individual must command himself. The individual must possess power so to improve, suppress, coordinate and combine the units of moral forces as to avoid weakness or even the appearance of it, and to arouse no distrust or antagonism. Antagonism in subordinates, whether justly aroused or not, is a great deterrent to the success of the superior. It is believed that too little attention is paid to this: when a superior feels a lack of hearty support and loyalty in his subordinates, he may well conduct a close self-examination to see if the trouble is not in his own moral makeup rather than in that of others.

The point is made that the quality of loyalty is moral rather than mental, and that as a rule it is a normal attribute. Its absence arises either from lack of mental balance in the subordinate from which a self-appreciation has run riot, or a similar failing in the superior from which a lack of consideration for others induces in the subordinate a resentment developing into an undesire to conform to any system imposed by the superior, and this entirely independent of the inherent worth of such system. Even an admittedly weak superior may have loyalty, and indeed such loyalty of subordinates may make a less failure or perhaps even a partial success of an inherently weak program. Merit in a program will insure neither loyalty nor the reverse; but proper moral qualties of the superior will always govern, hence it behooves the superior to acquire such qualities.

Nothing in the foregoing must be construed to commend a striving for popularity. Popularity is the incidental reward and not the goal, and it is not by any means a sign of the mental balance sought for. As a by-product, popularity is, rightly, to be highly prized; but as a goal, it is to be shunned, for its attainment under such conditions has surely been at a sacrifice of mental balance.

Passing now to the mental qualifications making up military character, we find their number precludes enumeration, but, by excluding such as do not pertain to military character, something may be done and a few taken up for examination.

The following quotations from General Bernhardi's *Cavalry in Future Wars* enumerates and, by the context, illuminates some of these qualifications:

> Nothing helps *decision* more than a complete *intellectual command* of the situation.
>
> Where he, with *clear purpose* before him, acts with *daring* and *thorough comprehension*, it is in his power to intensify this momentum many times over.
>
> Failure in *clear conception* of *mission* and *tactical training* and *loss* of *chance* to recognize and *seize opportunity*.
>
> [The] commander, *clear as to how he* means to carry out his purpose, makes his orders to subordinates clear.

More on the subject of clearness of conception of mission and of how the leader proposes to carry it out, is not necessary. Evidently, if the leader does not thoroughly grasp his mission, he cannot transmit his ideas. Not only is clearness of understanding necessary, but the military man "must exercise such *prevision* as not to be overtaken by circumstances." Further, it is "suicidal to conceal purposes from executive organs."

"Privilege," said the Bishop of the Philippines recently in a sermon, "must be translated into responsibility, else privilege will run riot. The leader is given privilege and he must feel the responsibility."

> The leader's task is many sided and he can only prove equal to it when all subordinates *support* him with utmost *good will* and *reliability*, acquired by *personality*, *trust* in *ability*, and *experience in success*. * * * The leader must stimulate and inspire. * * * A leader must be an *absolute master* of the *technical side* of his own arm. He must be ready to *enter* into the *spirit* of the widest strategical considerations of the superior *command* and according to circumstances to *act in harmony* with them on *his own initiative*. He must know the *spirit*, the *methods* of *fighting* and *peculiarities of other arms* so as to intervene at the right time and place in action. He must, with *swift determination*, *combine boldness with circumspection* and, in addition—must possess *inexhaustible activity* of mind and body.
>
> [The] commander [must] use his *judgment* as to *where chief weight* of *mission lies*.
>
> *Initiative* alone guarantees success, it forces the enemy to accept the law from our hands. Endeavor then to instill as much as possible into defense.
>
> *Hold command* while *allowing all possible initiative*, not wilfulness, to subordinates.

"Mistakes once made can rarely ever be remedied," and because of the shortness of time for consideration and decision, *quickness* of *perception* is essential. This is the "*result of education—of experience.*"

Many books have been written setting forth the qualifications that must underlie a strong and effective military character; and the slight divergence of opinion as to enumeration is so remarkable and the information as to what constitutes military qualifications of character so complete, that little need be added here in considering them separately. It is only when all these qualities are to be moulded into an harmonious whole does the trouble begin. Many are so diverse that at first sight their existence in the same character seems impossible. Submission to the will of the superior and initiative seem queer bed fellows, and there are many such mismates in the team. There is a borderland of extreme haziness encountered in passing from the requirements of one to those of another. Any rule laid down will be so clouded by exceptions as to make it of no value.

The expression, mental balance, has already been introduced; and perhaps that term may be used in this connection to express an indefinable quality that enables its possessor to meet the difficulties, to delimit the spheres of activity of the opposing qualities by imposing boundaries flexible under varying conditions. Mental balance coordinates and governs the qualities of an individual character; but that is not sufficient: there must exist a quality that coordinates the several individual characters that are thrown together in the various relations of leader and subordinate. Such a quality may be designated *tact.* The term is in general use, and is defined in the *Century Dictionary* as an "intuitive sense of what is true, right, or proper"; and, further, tact is "the ability to do or say what is *best* for the intended effect." The first sense eliminates craftiness or underhandedness and presents the quality in a passive sense; the second indicates strength in securing a result.

It is desired to direct consideration specially to the qualities here called mental balance and tact as the overlords of the other qualities. Observe; tact does not imply weakness; nor does it yield its purpose to opposition. It pursues a course that produces results; and, moreover, *best produces* those results. What more can be done? A spurious tact may result from weakness: an individual may be a trimmer. Results may be thus produced, but not *best produced.* A so-called strong character without tact may produce results by overriding all opposition, whether such opposition is to the means, the method, or the object of production. A strong character with tact in command will *best produce* the result, possibly turning opposition into support and strengthening the position for the next move.

"To hold command while allowing all possible initiative, not wilfulness, to subordinates." Where does wilfulness begin and where does legitimate initiative end? The superior desires to give latitude for initiative. Orders must indicate and allow for this by conveying don'ts as well as permissions. The tactful superior knows how to put in the don'ts—not necessarily as the prime idea, but as limitations on the latitude allowable. The subordinate feels the tactful handling; and, if himself tactful, appreciates it, while he none the less observes that the don'ts are there. This commander has added to the fortress of loyalty of his subordinates, without whose support the accomplishment of his mission must prove extremely difficult or even fail.

Tact is "adroitness (in appreciating circumstances and acting accordingly); skill (in saying or doing what is most appropriate to the occasion); quick judgment; nice perception; cleverness; dexterity; knack; *savoir faire*" (*Soule's Synonymes*).

The whole category of qualifications, as treated by writers, continually shows infringement by one on the other. A writer announces a quality as necessary in the extreme and proceeds to enlarge on what the quality is and what advantages its possession confers. He waxes warm; and the more ardent his pursuit to gather in all the good things, the more surely and suddenly does the pitfall appear. A new paragraph *begins* with a *but.*

Von der Goltz shows at length the desirability of taking officers from a special class taught to consider themselves as such; *but,* he adds, egotism is the bitterest enemy of efficiency. Especial value is laid on education because it is the basis of noble and moral qualities; *but* we ought not to cling exclusively to scientific attainments.

Youthful heedlessness implies bravery and courage, both of which qualities are necessary constituents of military character; so the officer should carry his youthful ardor along with him as he increases in years; *but* experience is education, which is a fundamental also.

Combativeness; *but* self-restraint.

Courage of responsibility; *but* not presumptuousness.

Energy; *but* caution.
Imagination in picturing probable position and condition of an enemy; *but* not fantastic fears.
Initiative; *but* compliance.
Theoretical; *but* practical.

In these and many other examples that occur to the reader, the function of tact is to wipe out the buts and harmonize the whole. There are many commandments, but the greatest of all is *possess mental balance and military tact.*

Tact is "an intuitive sense of what is * * * right, etc." The idea might better be expressed by the word *involuntary;* or, better still, by *subconscious.* Intuition may carry some idea of a God-given or hereditary character of the quality, and so free the individual of responsibility in the acquisition of tact. Subconscious is introduced to convey the idea of an unpremeditated mental action, but precludes uncertainty or guess work. This subconscious action is the result of an education in which unlimited experiences have, like water dropping on a stone, made an impression attributable to no special experience or drop, and hence is of untraceable source. Recall your first attempts to ride a bicycle, with their slow mental processes of endeavor to determine on some action calculated to prevent a fall. The labor was often unavailing, but left an impression on the mental faculties and perhaps on the physical parts. Revert now to a later experience: a similar crisis is passed and the conscious mind is not aware of the act. Experience has done its work and the duty of balancing the bicycle is relegated to the subconcious department of the mind. It is now intuitive in the sense of the definition. It is scarcely hereditary, as one's ancestors had no opportunity to acquire this peculiar accomplishment.

Loyalty in a subordinate is insisted on as a necessary qualification. It is defined as fidelity in duty, service, love, etc.

> Master, go on. I will follow thee to the last gasp, with truth and loyalty. (*As-You-Like-It.*)

> The conformity of our actions to our engagements, whether expressed or implied, is fidelity. * * * If in such a case, love is added to fidelity, it becomes loyalty. (Whewell, *Elements of Morals.*)

Distinction is made between fidelity and loyalty. Both require conformity of action, but the one conveys the idea of a cold blooded hewing to the line by purely mental processes;

the latter is a conformity warmed up by love; it implies sentiment; carries the idea of willingness; of cheerfulness; of presence of soul and of everything that makes for life; of live conformity—not dead compliance. The distinction between fidelity and loyalty is not insisted on as an abstract question; but the words are used in an endeavor to differentiate between an active support and a passive following in conforming one's actions to one's engagements, in carrying out the orders of a superior. Perhaps if the phrase, *military tact*, were substituted for love so that fidelity plus military tact equals loyalty, the whole story would be told and conformity would be best produced. When all the desirable military qualities (the moral, presided over by mental balance, and the mental by military tact) are martialed best to produce the result, loyalty underlies the conformity.

Leaving for a moment this quality of loyalty, which is exercised from a subordinate to his superior, consider a quality exercised by the individual as an individual. It is not uncommon to hear the expression that every military unit is a cog in the wheel of a well organized army. The illustration is very fitting—when it fits—and conveys the idea of a unity of purpose and economy of effort as opposed to undirected individual endeavor with wasted energy. The illustration is happy so long as it is an impressionist picture. If details are taken up, however, the inevitable *but* appears. That very individuality of action, designedly suppressed in the analogy, is the very spirit of the whole machine. This showed itself when the dense masses of troops gave way before more mobile columns, and again when the English thin red line became a factor in success.

If the unit is but a cog, its exact action is predetermined, and hence the condition of action foreseen. If the rule of action of the unit, in connection with others, under all circumstances, may be determined and laid down, there remains but to know the special conditions in any case. But there is the rub. Conditions cannot be known with any exactitude, and hence rigidity of rule fails, while chaos exists in the absence of rule.

It is obvious, then, that rigidity will be fatal, and the absence of rule with full individual freedom will result similarly. If the unit's action concerned itself alone, the case would be simple; but the analogy of a machine again applies, in that complete action is dependent on the action of the parts.

Obviously, then, some flexible rule of action must be adopted: the unit must be held in certain bounds within which a flexibility must adapt it to circumstances. Can the flexibility be prescribed? No more so than the rigid rule, as the conditions are not known. This flexibility is a passive quality allowed by the release of pressure of rigid rule, and the quality of the individual unit that takes advantage of such flexibility is *initiative.*

Initiative is not so limited as here depicted and might have been defined in general terms. The objection, however, lay in the certain appearance of the all-pervading *but;* so it seemed best to work up to the idea of initiative from considerations of loyalty. It is in this restricted sense that it is considered.

A conformity of action, loyalty, is paramount, and there is no *but* in the general statement. However, there are times and circumstances where conditions cannot be known or are erroneously assumed. Here there is no question of abandonment of the rule of conformity, but an absence of anything to conform to. What now? Shall the individual unit sit still? Or shall he avail himself of the quality of flexibility in the situation recognized and, perhaps, even created by his loyalty, his military tact, so soon as conformity was made of no effect from the absence of any possibility thereof? To illustrate: General A desires to send a messenger to General B, unobserved by the enemy. Directions state that the messenger "shall proceed along a certain road, through a gate in a high wall to Bald Hill, unseen by the enemy." The messenger proceeds, but finds no *gate* or finds the gate blocked. Conformity requires him to proceed along a road, *through a gate,* to a hill. Rigid conformity is impossible and initiative must come into play, for loyalty—fidelity with love—demands that the superior's wish be carried out. Initiative pushes the individual on. The flexibility allowed is how great? In the answer to this question lies the solution of the relation between compliance and initiative. Military tact will require initiative to confine its activities to strictly loyal lines, and, moreover, will force on initiative the burden of proof that it is loyal. How shall initiative proceed? An examination of the mission in this simple case indicates clearly that the message shall be delivered to General B unseen by the enemy. All else is unessential, and the flexibility is evident. For further illustration, assume the mission not so clear. The messenger reaches General B after expenditure of much energy in going through the gate and incidentally exposes his act to the enemy. He has carried out all directions but one. Has he succeeded in his mission? If he has no more light than we have, a toss of a penny must decide; but tact is the intuitive sense of right to do what *best* produces the desired result. Observe the word intuitive; not dependent on heredity, but on education, on observation, on absorption of information as to passing events and conditions. If the messenger's surroundings are as barren as are ours, his faculties for intuition will advantage him none; but that is a most extreme case and he certainly will have had something, however little, to go on.

Initiative is subordinate to the compliance of loyalty *and must never supplant it:* the *burden of proof* lies with initiative that this is not done. Actions are ordered under assumed conditions, and so long as conditions are as assumed, initiative must bow. If the conditions really exist as supposed by the superior, and orders issued by him completely cover the situation, initiative, in failing to comply, substitutes his judgement for that of the superior and, to say the least, fails in loyalty. If, however, the conditions are different, a flexibility is indicated and initiative now has a problem—the same old problem of what next? Initiative must move; but it is a serious question to be prayerfully considered as to extent and direction. With moral qualities, governed by mental balance; with with mental qualities, under control of tact; with loyalty, which is fidelity with love, to test out so far as possible the scope and direction that initiative may take; and with a courage of responsibility, the subordinate must go ahead.

Loyalty primarily is from inferior to superior; but there is a loyalty to common cause between equals. The action resulting from this relation is generally known as cooperation. In athletic games this factor in success is called team-work, and its possession is striven for as a matter of course. There can be no two opinions as to the desirability of cooperation in military actions; but the indefiniteness and the many-sidedness of the situation prevents any attempt at laying down general rules of action: mental balance and military tact must guide cooperating units, and loyalty to the common cause or to the leader will further direct them.

That units have failed to cooperate on any special occasion is difficult to pronounce; but in the aggregate the lack becomes evident. Cooperation on occasion demands self-sacrifice. The spirit of true cooperation is loyalty between coordinate units, and contains the element of loyalty that differentiates the latter from fidelity. If each individual, "unconcerned about results or consequences to self, work with his whole heart and mind in the cause we serve," there will be cooperation.

Mental action is a physical exercise in that the blood, nerves, and brain are involved. When in good physical condition, the individual is best fitted for mental activity; moreover, a poor physical state reacts on mental condition. Some of the important mental qualifications, as courage, energy, determination, are closely connected with physical condition, and many reasons may be advanced in favor of a first-class physical development. The athlete is not necessarily a better military man than another. Here again comes in the *but*. Enough is enough, and good judgment must decide.

Writers have left little to be desired in setting forth what qualities are desirable in the military character, but less attention has been paid to means and methods of acquiring them. However, it is easily agreed that these may be covered by education, which is defined as mental and moral training —"cultivation of mind, feelings, and manners." "But education in the true sense is not mere instruction in Latin, English, French or history. It is the *unfolding of the whole human nature. It is growing up in all things to our highest possibility.*" (Clarke's *Self Culture.*)

The acquisition of fact is the foundation of education, but is not education. The mental exercise, the mental growth and expansion, in such acquisition, and the act of assimilating and coordinating the facts and in making deductions, is education, and education must be broad. "The higher the intellectual pinnacle on which the individual is placed, the wider becomes his horizon and consequently his appreciation of relative importance of each individual link in the chain." The farther the clouds of ignorance are rolled back, the better the light on the central picture.

The process of acquiring facts is simple, but the mental training presents a complex problem. Not only must material be furnished for mental work, but the desire for activity must be aroused. Rules may be formulated, but the actual training is the work of the individual. The schools afford opportunity for acquiring facts; but the post graduate school, whether it be an institution or simply every day work, must be depended on for mental training.

On this subject, Bernhardi says:

> The knowledge of the military sciences acquired at the war schools is on a very modest scale, nor is it indeed the business of these schools to give higher education in such subjects. Hence, it is all the more deplorable that the higher intellectual training of our cavalry officers practically ceases after the war school, because the practical day-to-day duties of their profession furnishes them with nothing that can replace the needs for higher theoretical training. Generally their attention is absorbed by the smallest of details, which, though each is of immense importance to the efficiency of the whole army, are not calculated to widen their intellectual horizon, and in the few great maneuvers in which an officer might find an opportunity of enlarging his knowledge, he finds himself lacking in foundation necessary to make full use of it.

This brings out prominently an obstacle to mental training and the necessity for schools such as at Leavenworth, Washington, Newport, and Fort Monroe; so it may be profitable, at this point, to develop at some length the subject of education, not only for the purpose of stressing its importance in the formation of the military character, but also for the purpose of indicating how important character is in the imparting and the acquiring of military education. The two are interdependent.

In furthering general education, human nature must be considered and an air of education must pervade the surroundings. It must be the fashion to be at work; hence, over and above the facilities for research they offer, the schools are necessary for continually returning to the routine services men imbued with the idea that it is fashionable to work at one's profession. The individual mind must be interested, even if the lowest of all incentives, competition, is invoked to accomplish it. His attention attracted, the individual is ready to proceed with his training and needs only that correct principles be laid down for him.

In many cases, the first move is to disabuse the mind of the idea that theory and practice are opposed. It is not uncommon to hear the beginner at these schools say that the "*course is all theoretical*"; by which he means to convey the idea that it is not practical, that it is all very well for the section room, but won't work when there is really something to do. And the expression finds voice oftenest when the problem is knottiest and needs more preliminary education than the objector possesses. It would be far simpler for him to go at it with brute force and awkwardness, or, as he would say, practically. The better the student, the sooner is the idea dropped.

Some, of course, are hopeless. Those who drop it have outgrown the belief that the qualifications that make up the practical character are obtained by some unexplainable hocus-pocus, rather than by education. This is an important step and should not be lost sight of. The individual should be led to it, not driven. If he takes it willingly, he may be trained up to his mental capacity; but if he balks, he will go further only under the lash.

The leaders, or, as we call them, instructors, must have tact best to produce such results, and no rule may be laid down for their guidance. Of all men, they must have infinite patience and understanding of men; they must be able to put themselves in the place of the student and appreciate his difficulties and understand his point of view. Decisions are necessary, but they must be made with a show of reasoning and with due consideration for any attempt at reasoning by the individual against whom the decision is made.

On this point, it is suggested that, in maneuver board games, individual ideas should be given full opportunity, and independence should be encouraged, provided it is backed by a thought that has any basis whatever—or sometimes even when it has none; for the working out of the plan will be an education, and, if wrong in principle, the individual will then not be "convinced against his will." The individual advancing the idea, even though it prove without merit, should not have it charged against him in the mind of the instructor who may later be called on for his estimate of the situation as regards the individual. Greater advantage results from the interest taken than loss from the relatively poor merit of the case; for, with interest alive, the instructors are in position to drive home a live principle. Moreover, it might work out under the hand of the proposer. Who knows? Napoleon did some very queer things with the military rules of the times.

Instructors must not antagonize and must not pose as infallible. It must be patent that conclusions and decisions are based on reasoning. The function of instructors is introduced only to indicate that the attitude of students is of importance, because the good from mental training far surpasses that from the facts acquired.

One of the first things the student learns, if in earnest, is his lack of knowledge. Finally, he begins to feel confident that he is on the road. Two remarks overheard will illustrate. After working over a problem for a day, an officer remarked, "I thought I wanted to be commander in chief, but I don't." This was, of course, merely a reflection of a mental state—a recognition of the problem of responsibility and his unpreparedness therefor. He had made a long advance in education. Later, after several problems had been solved: "I went at the first problem like a chicken with its head cut off, flopping from one thing to another—flopping and bleeding and dying. But now, as I read this new problem, I see at once a logical way of beginning." The writer was in the same category and both were being educated fast.

It is desired to emphasize the point that the subject matter of study is of less importance than the method of study—that the mind should be taught to consider all points of view and to reason therefrom—that a correct method of reasoning is to be established. All facts in the case must be laid out, even those that seem unrelated, and conclusions must be based on their consideration. *In original investigation never array the facts in the case or study them with a view of establishing a preconceived conclusion.* The decision will not be broadly based; and, what is worse, an error will have been made in mental training.

A fuller investigation along these lines will show that, if faithfully cultivated, the faculty of reaching conclusions based on good reasoning will be enlarged till, finally, in the less complicated cases, decisions seem intuitive. This is far from the case, however; the mental quality of tact has simply been developed and exercised till the individual is said to be practical as opposed to theoretical. Because the conclusion has been quickly reached without sign of any theoretical considerations, the uninitiated dubs the decision practical. He will recognize the educational training by which practical decisions result from the study of theoretical considerations only after he himself has taken some steps in that training.

At the risk of prolixity, one more quotation is introduced further to impress the idea that a mental training along correct lines creates a faculty that seems inborn, because its operations are obscure; and that, because its operations are obscure, the uninformed characterize the faculty as *practical* sense, in contradistinction to *theoretical* sense, which is belittled. The quotation deals with this faculty.

> Military tact is that which hits upon the right thing, almost unconsciously as it looks, and with power of personality which never fails to act, and which knows how to master men and matter. These are often considered

inborn, but a final analysis is sure to indicate the mental faculty of grasping and assimilating facts and principles, combining and eliminating till a product results which may have lost all resemblance to original form and appears to be inborn.

In mental training, seek the spirit of things; get at the true inwardness and establish principles. While, of course, facts must be acquired, and the military individual must be fully informed in the technique of his own arm and acquainted with that of others so that he may best coordinate his work with the general scheme, yet even here the spirit of the facts and the technique must be looked for.

If the proper method is followed, mental training goes on in the acquisition of facts. In searching history for principles underlying success, the student must recognize that the concrete facts stated are as well established as possible, and must learn to attribute to each no more importance than belongs thereto. In doing this the student officer acquires facility in reaching decisions in his estimates of military situations, and, indeed, in situations met in every-day life.

If such training is desirable, it becomes of first importance to decide on some means for attaining it. The military individual must be brought to recognize his lack of education and afforded opportunities for supplying it.

The schools mentioned are excellent as far as they can reach, but their limitations are evident. They correspond to colleges and reach a limited number for a short period. Their work must be supplemented by primary schools on the one hand, and schools of practice on the other. Their courses are too short for complete training, as that is a slow and continuous process. Moreover, after the training is completed, the mind must not be allowed to rust. In professions, other than military, the successful man keeps up with the times by active participation in actual professional work. In the military profession, the actual work cannot be performed, but some approximation thereto may be had. This opens up a study beyond the limits assigned to this discussion, which deals with the formative period only.

The means selected for training should be thoroughly adapted to the requirements. In character formation, facts are needed and training is needed. The first may be furnished through the garrison schools of the army, and correspondingly in the navy. These are prescribed and meet the requirements to a certain extent as primary institutions; but only very incidentally help in mental training, for which there are no primary schools.

The quotation given hereinbefore deplores the fact that every day routine duties so fill the time and minds of junior officers as to preclude training. Is it not possible to use these very duties for mental training? Even so simple a duty as fixing a boat schedule may be made a study to advantage in accustoming the mind to work systematically in everyday things. Not even the simplest detail should be decided without a study of the subject from all points of view.

If this system should be established, then officers would live with their profession. It would be an ever present and recognized obligation instead of a theory apart. If the theory of investigation were applied in the small details of everyday duty, the mind would very soon work automatically along correct lines, military tact would soon become intuitive, and practicality in its highest form would be attained.

Is it possible to institute such a system? Is it practicable to induce military individuals to live with their profession ever in mind? The first step is to arouse interest, for such a system cannot be put into execution by orders. The answer to such an attempt may be, "Bosh! more theory."

How much commanding officers can do in putting such a system into effect is a question that calls for thought. It is suggested that, whenever a subordinate brings up a program for the execution of even the merest detail of routine, he be asked for his reasons for his decision. If in the reasons given the question appear not to have been considered from all sides; or if the reasons indicate that they are advanced in order to support the decision, rather than that the decision is based on the reasons, a few questions may cause the subordinate to think; and, if he really thinks, a little training is effected.

The utmost tact will be necessary best to produce results; but the idea seems to merit trial, because at present there is nothing else offered to take its place.

Get the individual to thinking about his profession; and get him to feel that his professional acquirements do not end with a few concrete technical facts, nor with the solution of a few such problems as may be given out in or from the schools, but that it must embrace a mental training that will enable him to grasp quickly the vital points of problems ever varying as to conditions, and to solve them intuitively and with dispatch.

A military writer says the individual must study theory in times of peace, but must leave it behind in time of war. This idea he does not explain; but it can be sound only if he means that the mind is so trained in correct theory in peace that it can act with military tact on the problems in war requiring dispatch. He has not left his theory behind, but only his theorizing. He has become practical in the true sense, and not in that false sense in which the word is so often used. The time for theorizing has passed; he has no time for it, but depends with certainty on his mental accomplishments acquired laboriously in peace under correct rules of theory.

In an address to the graduating class of officers at the Army War College, Senator Root stated that we are not a military nation, and that the main function of our small regular army is that of instructor to the mass of citizen soldiery that must be called into service for war. This idea adds a new qualification to those necessary to make up a strong military character: the individual must be an instructor, a qualification much underrated. To know a thing does not necessarily carry with it the ability to teach it to others.

Great care must be exercised in selecting instructors for our volunteer troops. Military tact is a prime qualification to be sought for in selecting them. It is quite possible that the available rather than the specially qualified man may be detailed for this work, unless due consideration is given to this factor in his make up.

It is recognized that a sufficiently large body of civilians is not being reached in the attempt to prepare a second line for our small body of regulars, so an effort is being made to extend instruction to college men, who will occupy leading positions in their communities and who will form a class from which officers will naturally be drawn. The instruction for these men will be in the nature of character forming, and the points brought out in this discussion will apply with full force.

Finally, in closing this paper with a plea for earnestness in the work of character building, the following quotation from Bernhardi seems very apropos:

> In this sense it is the duty of each individual amongst us, unconcerned about results or consequences, to work with his whole heart and mind in the cause we serve; and the more resistance to be encountered, the greater the obstacle to overcome, the less may we shun the struggle, for here also the old truth holds good—*per aspera ad astra.*

COAST DEFENSE IN THE CIVIL WAR*

THE PASSAGE OF FORTS JACKSON AND SAINT PHILIP†

By 1st Lieut. WALTER J. BUTTGENBACH, Coast Artillery Corps

General Situation

New Orleans, the metropolis of the South, had in 1860 a population of 170,000, and had shipped in 1860-61 sugar to the value of $25,000,000 and cotton to the value of $92,000,000, which gave it rank as the chief commercial port of the south. It was also a strategic point of great importance. Its position controlled the commerce of the South, which then passed down the Mississippi River.

The many mouths of that river, and the frequency of violent gulf storms made it difficult to maintain a blockade for the purpose of breaking down the extensive commerce between the river and the ocean. With New Orleans in the hands of the Federal troops, the Confederacy would be cut in two and would experience great difficulty in keeping up its supplies from over sea.

A Federal force under General Grant was working down the river and in April, 1862, was at New Madrid and Island No. 10, pushing on to Memphis, which surrendered the following June, leaving Vicksburg still to be taken.

Special Situation

In the beginning of 1862, an effective blockade being maintained on the Gulf, the Federal administration turned its attention to the capture of New Orleans.

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* See note to "Coast Defense in the Civil War, Fort Sumter, S. C. (First Attack)," in Journal U. S. Artillery for March-April, 1912.

† Though not strictly an account of an operation in coast defense, this account of the attack on Forts Jackson and Saint Philip is introduced at this point in the series of articles on "Coast Defense in the Civil War," in order to present in chronological order accounts of operations of guns afloat against guns ashore that took place during that war.

This subject had been brought to the attention of General McClellan as well as of the Secretary of the Navy, and it was decided to make up a joint Army and Navy expedition, the forces of the Army being under General B. F. Butler and those of the Navy under Captain Farragut.*

It was comtemplated to make a purely naval attack and then, after the forts were taken, to have the Army hold the city. The plan adopted was one laid before the President by Mr. G. V. Fox, the Assistant Secretary of the Navy, and was based on a memorandum drawn up by General Barnard, Chief Engineer of the Army of the Potomac.†

OPPOSING FORCES

CONFEDERATE

The defenses protecting New Orleans may, in general terms, be said to have consisted of an exterior line of forts and earth works intended to prevent the entrance of armed hostile vessels into the river, and an interior line of works, about eight miles long, in the immediate vicinity of the city, and constructed almost entirely with a view to repelling an attack made on land by an infantry force. Where this second line crossed the river below the city it was to be strengthened by batteries.

General Lovell, the Confederate commander, made an effort to obtain some heavy guns, especially 10-inch columbiads and sea coast mortars, from Richmond and Pensacola; but none could be spared. The general opinion seemed to be that the city would not be attacked from the river side; so General Lovell had to content himself with making the best defense possible with the guns, etc., he had on hand.

Subsequently, however, upon the evacuation of Pensacola, some additional guns, including 8 and 10-inch columbiads, 10-inch seacoast mortars, and rifled 42-pounders, were obtained.

The principal works with which we are concerned are those which were at Forts Jackson and Saint Philip, together with the adjacent water batteries, as it was upon them that the main brunt of the attack fell.

Forts Jackson and Saint Philip were situated at Planchmine Bend, on opposite sides of the river, twenty-five miles above the head of the passes and some seventy-five miles below New Orleans. Fort Saint Philip was on the left bank and Fort Jackson on the right bank, a little below Fort Saint Philip. At the time of the passage of the forts, the woods on the right bank had been cleared away below Fort Jackson almost to the extreme range of the guns, thus affording no shelter from observation. The left bank was treeless. The country is generally flat, and at time of high water the surface of the river is above that of the surrounding country, the river being kept in its channel only by an extensive system of levees.

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* See *Battles and Leaders of the Civil War*, Vol. II, pages 23 to 26; see also page 70, same volume, for a different version.

† *Official Records of the Union and Confederate Armies*, Series 1, Vol. 15, pages 413-421.

Fort Jackson was a bastioned pentagon, casemated and built of brick. Its fronts were about 110 yards long and in good condition. The scarp walls were twenty-two feet high, measured from the offset of the foundation, which was nearly at the bottom of the wet ditch. This ditch was about six feet deep, leaving the top of the scarp about sixteen feet above the surface of the water in the ditch. The ditches were flanked by one 24-pdr. howitzer in casemate in each of the flanks. There was no counterscarp wall. The ditch was revetted with timber running up to the edge of the water, from where the earth sloped more than 45°. The parapets were not carried around the flanks and faces of the bastions for fear their weight could not be borne; so there was not much room for musketry fire on the flanks, it being possible to station on each flank only a few riflemen behind the top of the scarp.

The faces of the bastions could be lined with infantry, as they were hollowed out, leaving the top of the scarp to serve as a parapet.

The two curtains bearing on the river were casemated for eight guns each, the guns, due to their mounting, having but a limited sector of fire. The parapets of the two water fronts were arranged to receive twenty-two channel bearings guns. The parapets of the other fronts were arranged for sixten more barbette guns, a portion of which bore directly upon the channel.

The three land fronts of the work were covered by a glacis-coupé, with a covered way. The two terminating branches of this covered way bore upon the channel and were arranged for eight or nine guns in each. The branches of the covered way of the west front bore well upon the channel above the fort and were arranged to receive thirty-one guns.

The entire work was thus arranged for the following armament:

Casemate guns	16
Barbette guns on two channel-bearing faces of main work	22
Barbette guns on two extremities of glacis-coupé, having same bearing on two faces	17
Barbette guns in covered way of west front (looking up the channel)	31
Barbette guns on other fronts	16
Exterior battery communicating with covered way of east front arranged for guns (not mounted)	25
Total heavy guns	127
(Ten flanking howitzers not included.)	

At the time the Confederates obtained possession of the work in 1861, there were in it:

16 32-pdr. guns
26 24-pdr. guns
10 24-pdr. flanking howitzers
14 24-pdr. casemate carriages
9 24-pdr. flank defense howitzer carriages
12 24-pdr. barbette carriages

Most of the carriages were not in good order.

Strenuous efforts were made to put the work in order, and its armament at the time of the attack of the Federal fleet was essentially made up of the following:

Casemate
14 24-pdr. smooth bore guns
10 24-pdr. flanking howitzers
Barbette
2 10-inch columbiads
3 8-inch columbiads
1 7-inch rifle
6 42-pdrs.
15 32-pdrs.
11 24-pdrs.
1 8-inch howitzer, dismounted
1 7⅜-inch howitzer
2 8-inch mortars
Parade
1 6-pdr.
1 12-pdr. howitzer

In all, 68 guns.*

The glacis-coupé was surrounded by a wide wet ditch having a little over three feet of water in it.

In the center of the fort was a defensive barrack (citadel) of decagonal shape. It was intended to be made a bombproof by covering the 1-foot square timbers on the ceiling with earth. It could accommodate 400 to 500 men. There was also considerable more bombproof cover in the casemates and galleries; so the garrison could be well sheltered from bombardment.

With reference to position, the salient of the north bastion was about 140 yards distant from the river and some 110 yards from the levee; and the river itself is about 700 yards wide.

Just outside of and below the main work, covering the approach to it, was a water-battery consisting of:

1 10-inch columbiad
1 10-inch seacoast mortar
2 8-inch columbiads
2 32-pdrs. rifled, (throwing projectiles of 60 to 80 lbs.)

This battery had its crest fourteen feet above low water; the covered way batteries, sixteen feet above low water; and the main work, twenty-four feet above low water.

Of the guns in Fort Jackson, the flanking howitzers and some half a dozen of the 24-pounders and 32-pounders could, from their position, have had little or no share in the engagement with the fleet.

Fort Saint Philip was originally built by the Spaniards, and later completed by the Americans. It is very irregular in shape and occupies a quadrilateral space of about 150 yards by 100 yards.

The front towards the river (first built) had a bastioned trace, and the other portions were added later to enclose the work and give it some semblance of flanking arrangements. The walls, of brick originally, had been strengthened, additional thicknesses of masonry being added and earthen parapets provided all around the work. The wet ditch was deepened so as to have at least six feet of water at the lowest stage of the river. As a general thing, the scarp wall on the land fronts was sixteen to seventeen feet high, measured from the bottom of the ditch, and on the water fronts fourteen to fifteen feet high. The part of the ditch, however, near the scarp wall was not more than two or three feet at low water, the deepest part of the ditch being generally nearer the counterscarp. This counterscarp was not of brick, but was simply a flank revetment similar to that of Fort Jackson.

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* A report in the *Official Records* gives the armament as 69, Dec. 1861. The statement here given is from *Battles and Leaders of the Civil War*, Vol. II, page 75.

There was a postern and drawbridge on the western face and another near the most northern angle of the works.

Two external batteries (earthen) had been built in connection with the fort, having the usual arrangement of wet ditches, parapets, etc., and were intended to mount twenty-two guns on the water faces, and six 24-pdrs. on the extremities and rear.

The main work of the fort was arranged to receive some twenty heavy guns bearing directly on the channel, besides some twelve or more bearing on land; the guns were to be in barbette and very low, the crest of the parapets being but fourteen feet above low water and nine feet above ordinary high water.

Its armament at the time of the Federal attack consisted of the following:

4 8-inch columbiads in barbette
1 24-pdr. in barbette

Two water batteries were built outside of the work:

Up-stream battery.—
16 24-pdrs.

Down-stream battery.—
1 8-inch columbiad
1 7-inch rifle
6 42-pdrs.
9 32-pdrs.
4 24-pdrs.

In all, 42* guns commanded the river below the bend.

In addition, there were:

In the fort,—
1 8-inch mortar
1 10-inch "
1 13-inch "

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* The report in *Official Records, etc.*, gives the armament as 46 in Dec., 1861. Reports conflict as to the armament of all these works. The statement of the armament given in this paper is taken from *Battles and Leaders of the Civil War*, Vol. II, page 75.

On the parade,—
1 6-pdr.
1 12-pdr.
1 24-pdr. field howitzer
Below and to the northeast of the lower water-battery,—
4 10-inch sea coast mortars

These last pieces had no appreciable effect upon the contest; their action is hardly mentioned in the reports of the fleet.

Fort Saint Philip is about 700 yards higher up the river than Fort Jackson and the distance between the nearest salients of the main works is about 1000 yards.

Thus we find that, from a point in the river a mile and a half from the lowest battery of Fort Jackson to another point a mile and a half above the nearest up-stream bearing battery, we have a distance of some three miles to traverse, two miles of which are under the fire of over a hundred guns, and the rest under that of fifty to a hundred. With vessels then in use, taking into account the current of the river, three and a half miles per hour, it would take approximately twenty-five minutes or half an hour to pass over the distance, which will give one a fair idea of the difficulties involved in attempting to pass the works.

However, it must be borne in mind that many of the guns in the works were only 24-pdrs., while the garrisons holding them were made up of volunteer troops, militia, etc. The total number of troops was some ten companies, 1100 men approximately, counting those both in the forts and in the outside works. The number in each of the forts themselves was probably 200 or 300. Additional troops were stationed up the river along the second line of defense.

As indicating the character of some of the troops it is mentioned in a Confederate report that one of the companies assigned to a water-battery was raw, undrilled, perfectly ignorant of the use of even the shotguns with which it was armed, and had never been drilled as artillery. Furthermore, many of the garrison were foreigners who, it was said, had volunteered for garrison duty to avoid being impressed into the Confederate field armies, their sympathies being Northern.

The supply of powder in the forts seems to have been ample. In January, 1862, there was on hand 55,000 pounds, and more was procured later, the exact amount not being known.

In concluding this statement of the Confederate land forces there should be mentioned, as affecting their availability, the fact that there was excessively high water at the time. The parade and the floors of the casemates at Fort Jackson were from three to eighteen inches under water, and Fort Saint Philip was in a similar condition, though the water there was not quite so deep. The clothing and the feet of the men in the garrison were always wet, the men being thereby exposed to much discomfort and sickness.

Besides the land defenses, there were vessels of various types pertaining to the several organizations, State and Confederate.

Of the Confederate Navy there were present:

Louisiana[*]	2	7-inch
	3	9-inch S.B.
	4	8-inch S.B.
	7	32-pdrs., rifled
Steamer *McRae*	6	32-pdrs., S.B.
	1	9-pdr., amidship
Steamer *Jackson*	2	32-pdrs., S.B.
Ram *Manassas*	1	32-pdr. in bow (carronade)
Two launches	1	howitzer, each

Of Louisiana State gunboats there were present:

Governor Moore	2	32-pdrs. rifled guns
General Quitman	2	32-pdrs. S.B. guns

Several unarmored vessels.

Of River Defense Gunboats (converted towboats, etc.) there were present:

Warrior
Stonewall Jackson
Resolute
Defiance
General Lowell
R. J. Breckinridge

These vessels mounted from one to two pivot guns, 32 pdr., each. They were not under the control of the Navy at all, but were to cooperate with it. More will be said of these later.

The Confederate fleet mounted in all forty guns, of which twenty-five were 32-pdrs. and one fourth were rifled.

In addition to the armament, there was also a boom or obstruction placed across the river, as it was thought that the guns mounted ni the forts could not hinder steamers from passing, unless they could be detained for some time under the fire of the guns. A raft was built to obstruct the river, leaving in it, however, an opening large enough to let one vessel pass through at a time.

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[*] Though an ironclad and mounting 16 guns, yet this vessel lacked motive power and required tugs to move it about. It was practically a floating battery and in a very incomplete state. The arc of fire of its guns was only 40°; and, due to the smallness of the ports, the maximum elevations of the guns were from 4° to 6°, corresponding to a range of about 2000 yards.

The first raft built was carried away by high water, and then another was built, which also was damaged by high water and storms in April. The raft consisted of a line of spars and large timbers chained together and anchored at various points by sunken schooners. It was located opposite Fort Jackson and was covered by some seventy-four or eighty guns of the forts. It was felt that as long as this obstruction held, the city of New Orleans was safe. After having been partly destroyed it was not thoroughly rebuilt, and was found wanting when the time of the attack came, being in large part wrecked by parties sent out by Farragut just before he made his attack.

Torpedoes, or mines, as now called, were tried, but were not successful due to the great depth of the water (134 feet where the raft was put) and the powerful currents to be contended with.

As a measure of defense, fire rafts were made use of, not only for the purpose of sending them against the Federal wooden vessels to set them afire, but also as a means of lighting up the river to aid the Confederate gunners in their aiming.

There were certain small works, such as Fort Pike, Fort Macomb, the works at Tower Dupré, Lake Borgue, the Chalmette Batteries, and the McGhee works, which bore but little part in the combat and for that reason are not considered in this article.

FEDERAL

The Federal vessels consisted of practically two squadrons —the mortar vessels under Porter and the vessels under Farragut.

Besides nineteen mortar vessels (schooners), carrying each one 13-inch mortar firing a shell weighing 285 lbs., the mortar fleet comprised the *Harriet, Lane, Owasco, Clifton, John P. Jackson, Westfield, Miami* and *Portsmouth*, seven vessels attached to the mortar fleet and used to shift the schooners into position or to protect them from attack that they could not resist with their peculiar ordnance. The *Owasco* was of the same class as the gunboat *Cayuga;* the *Clifton, Jackson,* *Westfield*, *Miami*, and *Harriet Lane* were armed side-wheel double-ender ferry boats, practically used as tugs; and the *Portsmouth* was a sailing sloop.

Farragut's vessels consisted of seven sloops of war, nine gunboats, and one other vessel.

The sloops of war were: The *Hartford*, a wooden steam sloop, 1000 tons, 225 feet long, 44 feet beam, carrying 22 9-inch guns, 2 20-pdr. Parrott guns, 1 rifled gun on the forecastle, and howitzers in the fore and main tops; the *Brooklyn*, *Richmond*, and *Pensacola*, similar to the *Hartford;* and the *Oneida*, *Varuna*, and *Iroquois* of lower rating.

The gunboats were: *The Cayuga*, *Itasca*, *Katahdin*, *Kennebec*, *Kineo*, *Pinola*, *Sciota*, *Winona*, and *Wissahickon.*

The odd vessel was an old sidewheel steamer, the *Mississippi.*

Farragut's fleet, i.e. those under his immediate command, consisted of seventeen vessels, all regularly built for war, except the *Varuna*, which was a converted merchant steamer.

About 90 per cent of the batteries of the eight larger vessels were divided, as was usual, between the two sides of the ship; and, though a few guns were mounted on pivots which allowed firing on either side yet the number of the crew being based on the expectation of fighting only one broadside, only half of the guns could be used at one time, even in the rare event of having an enemy on each side. In estimating the number of available guns in a fleet of sea going steamers of that day, it may be roughly stated that 60 per cent could be brought into action on one side. In the Mississippi squadron sometimes only one fourth could be used.

Nine of the gunboats carried one heavy and one light gun, both pivoted; none of the fleet could fire dead ahead.

The attacking vessels which passed the forts carried 192 guns, and adding those on the mortar flotilla, some 110 in all, there were 302 guns on the Federal side, while against them were 126 guns in the works ashore and 40 on the Confederate vessels.*

Narrative of Events

Captain Farragut was appointed to command the Western Gulf Blockading Squadron January 9th, 1862. On the 20th of February he arrived at Ship Island, Mississippi Sound, which was then the naval base as well as the military rendezvous.

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* For details as to armament, see the tables on pages 73-75 of Vol. II, *Battles and Leaders of the Civil War.*

The squadron, after much work and unavoidable delay, was finally assembled. Of the ships sent to take part in the expedition, the lighter vessels, including the mortar boats, were taken over the bar by the 18th of March. Three ships of greater draft gave much trouble, two of them being gotten over by the 8th of April, and the *Colorado*, the largest, not being brought into the river at all.

General Benjamin F. Butler was assigned to command the troops, consisting of approximately 15,000 men—14,400 infantry, 275 cavalry, and 580 artillery. The military expedition left Hampton Roads February 25, 1862, arriving off Ship Island March 21, when it was joined by other troops that had preceded the main force. A force consisting of 6000 men (some 8 regiments and 3 batteries) was made up and sent to the Mississippi. It arrived off the passes April 17th. The remainder of the troops were kept behind at Ship Island as a support.

The plans of operation* were based on proposals of General J. G. Barnard, Chief Engineer of the Army of the Potomac, approved by General McClellan, and referred to Captain Farragut by the Navy Department.

It was comtemplated by the Navy that the mortar fleet should compel the Confederates to surrender by bombarding the forts; but after a bombardment of six or seven days it was evident that other measures were necessary; for ammunition was getting low, the men were worn out, and the vessels badly shaken up. The Navy plan, or what is known as the Porter plan (though it is disputed that Admiral Porter should have credit for initiating it†) was in the main the one followed. The mortar vessels during the bombardment were to fire a shell every ten minutes, and Fort Jackson, a casemate work, was to receive the largest share of the bombardment, only some three or four vessels being employed against Fort Saint Philip.

Two plans were contemplated: according to the first, the vessels were to run by the batteries at night, or in a fog; while according to the other they were to attack the forts by laying the big ships alongside, avoiding the casemates and firing shell, grape, and canister into the barbette positions, at the same time clearing the ramparts with the ships' guns in the tops, while the smaller and more easily handled vessels were to throw shrapnel at short range and assist in clearing the parapets and dismounting the guns in barbette. The large ships were to anchor with forty-five fathoms of chain with slip ropes, and the smaller vessels were to keep underway, some getting above the forts and opening a cross fire. The mortars, at the same time, were to keep up a rapid and continuous fire, moving up to shorter range.

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* See letter of instructions from General McClellan to General Butler. *Official Records of the Union and Confederate Armies*, Series I, Vol VI, page 694.

† See page 70, Vol. II, *Battles and Leaders of the Civil War*.

The objections to a run-by were, that it was not likely that an intelligent enemy would have failed to place obstructions across a channel protected by batteries, and that, should a run-by have been successfully made the enemy would still have been left in rear, so that the mortar vessels would have been left to contend against the forts and hostile ships still in existence. In such a case it would have been necessary, in order to bring past all vessels, to reengage the forts from above, as the forts would have to be taken before a free channel could be obtained. On the other hand, if the forts were taken, the moral effect would probably be great enough to open the way clear to New Orleans. Once having possession of the forts the fate of the city above would be settled.

It was thought the Confederates might hold their ground at English Turn and there make a last effort to hold out. So, if that place were found impassable by water, since there was solid ground there it was contemplated to bring up Federal troops, landing them below the forts and attacking the latter in rear, while the ships attacked in front. If the ships got by the forts and there were no obstructions, the ships were to push on to New Orleans and the surrender of the city was to be demanded.

It was stated that Fort Saint Philip could be taken by a combined army and navy attack, 2000 men being supported by the ships. The ditch could be filled with fascines and the wall easily scaled with ladders.

In accordance with this plan operations were commenced.

The first Federal reconnaissance was made April 9th, when one of the Confederate reconnoitering steamers was pursued and followed by two of the Federal gunboats, which up the river as far as the point of woods below Fort Jack- where they were forced to retire by a few shots fired at from the batteries.

n April 13th several Federal vessels went above the f woods on a reconnaissance and exchanged a few shots with the forts and then fell back. They were fired upon also by sharpshooters on the shore, but without much effect. On the next day the ships did not engage the forts, but continued shelling the woods and drove out the sharpshooters. Men from the ships interrupted telegraphic communication below the fort, removing wires and cutting down poles. In consequence, the Confederate troops were withdrawn from below the forts, the telegraph lines being abandoned, owing to difficulties involved in reconstruction.

On April 15th the Federal commander brought up the rest of the fleet, extending from the head of the passes to the point of woods below the forts.

During this time, orders were repeatedly given to the commander of the Confederate river fleet to send fire barges down at night upon the Federal fleet, but in every case failure resulted: the barges were generally cut adrift too soon and drifted against the banks directly under the forts, firing Confederate wharves, lighting them up, while obscuring the position of the Federal vessels.

On April 16th the Federal gunboats continued their reconnaissance around the point of woods but were forced to retire by the fire of the forts. Meanwhile the Federals were engaged locating positions for the mortar fleet, Commander Porter having the river triangulated and surveyed. Two members of the CoastSurvey were in charge; and in three days they covered some seven miles, including the forts, locating points for the mortar boats from which the exact ranges were known to the forts. These operations were conducted under fire and at an approximate distance of 2600 yards from the works.

On the afternoon of the same day (4:15 p.m., April 16th) the Federals ran out a gunboat and fired upon the fort, and under cover of the gunboat two of the mortar boats were brought out into the stream. From the mortar boats fire was opened upon Fort Jackson at 5 p.m., and was kept up for an hour an a half. The Federal vessels finally retired behind the point of woods.

On April 17th several fire barges were sent down into the Federal fleet, but they also were unsuccessful.

The mortar boats were finally gotten into the desired positions by April 18th.

Farragut did not have much faith in mortars. It is said his distrust of them arose from his knowledge that in 1815 a British fleet had unavailingly thrown 1000 shells into a fort at the very turn of the river where the attack by him was then being made. Commander Porter in his report says that "prophecies were freely made that the bottoms of the schooners would drop out at the tenth fire." However, the mortar boats being a part of the expedition, Farragut went ahead and Porter was given a free hand to make use of them.

The masts of the mortar boats were dressed off with bushes, so as to hide them better, and this was afterwards found to have been very successful, for never once during the bombardment were any of the vessels seen from the fort, although their approximate position was known. The mortar vessels were under the lee of a thick wood interwoven with vines. From the mast heads the forts could be plainly seen, while observers at the forts could not see the ships.

The mortar fleet was arranged in three divisions, the head vessel of the 1st Division being placed at a point 2850 yards from Fort Jackson and 3600 yards from Fort Saint Philip. The vessels were close to one another, and each had a position specially indicated for it.

The 1st Division consisted of the following: *Norfolk Packet, Oliver H. Lee, Para, C. P. Williams, Arletta, William Bacon, Sophronia.*

Next to the 1st Division was the 3rd Division, consisting of: *John Griffith, Horace Beals* (no mortar; not included as one of the 19), *Sarah Bruen, Racer, Henry Janes, Dan Smith, Sea Foam* (brig). All these vessels were anchored.

The six* vessels of the 2nd Division were on the northeast shore of the river, the foremost one 3680 yards from Fort Jackson, to which this division was directed to turn its attention.

The 2nd Division was composed of the following: *T. A. Ward, Maria J. Carlton, Matthew Vassar, George Mangham, Orvetta, Sidney C. Jones.*

When the divisions were all placed in position, signal was made to commence action and they opened in order, each one firing every ten minutes. This action began at 9 a.m., and as soon as the mortars opened fire, the forts responded with all the guns they could bring to bear. For some time the forts did not get the correct range: the hulls of the vessels on the northeast shore being covered with reeds and willows deceived

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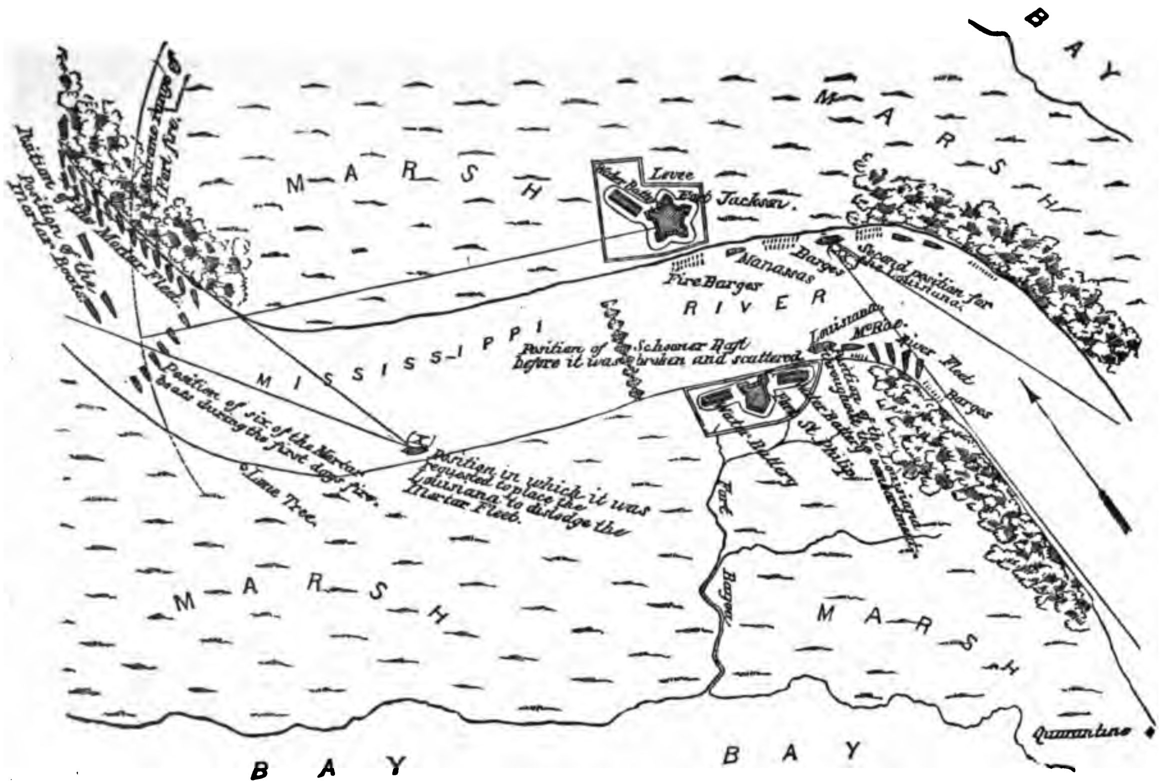
* See report of Lieut. Queen, May 3, 1862, in which he states the schooner *Adolph Hugel* was on the east bank and the schooner *Orvetta* on the west bank. *Official Records of Union and Confederate Navies*, Series I, Vol. XVIII, page 363.


BAY
MARSH
Levee
Water Battery
Fort Jackson.
Fire Barges
Manassas
Barges
Second position for the Louisiana.
RIVER
MISSISSIPPI
Position of Schooner Raft before it was broken and scattered.
Louisiana
McRae.
River Fleet
Barges
Position of the Louisiana throughout the bombardment
Water Battery
Fort St. Philip
Water Battery
Fort
Bayou
Position in which it was requested to place the Louisiana to dislodge the Mortar Fleet.
Position of six of the Mortar boats during the first days fire.
Lone Tree.
Position of the Mortar Fleet.
Position of the Mortar Boats.
Extreme range of Fort fire.
Quarantine
MARSH
MARSH
BAY
BAY

Official Records of the Union and Confederate Armies. 1387

Diagram of the Bombardment of Forts Jackson and St. Philip, La., from April 16th to April 24th. 1862. (The arrow near the right sf the diagram indicates the direction of flow of the river, which, between the sites of Forts Jackson and Saint Philip, is from west to east, Fort Saint Philip being on the north, or left, bank, and Fort Jackson on the south, or right, bank.)

them, and their shot and shell went over. In the Confederate reports it is mentioned that fourteen of the mortar vessels were concealed behind the point of woods and that the other six* were hauled out into the stream, just at the extreme range of the forts' heaviest guns. The Confederate fire was rapid, and as the shot and shell began to grow rather hot, Commander Porter asked that some of the gunboats be put in action to draw some of the forts' fire. For an hour and fifty minutes the head vessel of the mortar fleet bore the fire of the forts uninjured, and then withdrew to replenish ammunition. Gunboats were sent up by Farragut and reinforced the mortar vessels. By midday the fire on the vessels on the northeast shore (2nd Division) became so rapid and shot fell so close that the vessels were moved downstream and under cover. The *T. A. Ward* was struck, as also was the *George Mangham.* Both were moved down some 200 yards, which maneuver is said to have thrown the Confederates out of range and not to have been discovered for some two or four hours. The Confederates state their fire was generally short for lack of elevation and in consequence of the inferiority of Confederate powder. Even the gun nearest the mortar vessels, the 10-inch sea coast mortar, would not reach the Federal vessels with the heaviest charges.

At 5 p.m. Fort Jackson was in flames—the citadel was burned, destroying clothing, commissary stores, etc. Many of the men and officers lost their bedding and clothing, which greatly added to the discomforts of the fort, already under water.

A little after sunset (7 p. m.) the firing on the mortar boats was ordered stopped, though, as later found out, it should have been kept up. But, due to the uncertainty of night firing and to the men's having had nothing to eat or drink since daylight, it appeared advisable to stop it.

The 1st and 3rd Divisions were in action that day, and the expenditure of ammunition was over 1400 shells (the Confederate report says the Federals fired 2997 shells). It was observed that many of the shells were lost in the air due to poor fuses. On the south shore, pointing of the mortars could be done only by means of sights fixed on the mast heads or other expedients.

Against the fort the mortar fire was accurate and terrible, shells falling everywhere within it and disabling guns. When the bombardment commenced, officers and men were directed to retire to the casemates of the fort; and this being done, nothing remained but to receive the furious storm of shells poured in.

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* The *Horace Beals,* without mortar, made twenty.

An attempt was made to send fire barges down the river, but they were let go above the raft obstruction and they lodged under the forts. Furthermore, no guard boats were on duty below the raft, so the Federals were able to send two launches to continue their reconnaissance up to the very raft itself.

It was afterwards found out that this day's firing was more accurate than any later.

The 13-inch mortar at Fort Saint Philip this day became useless after the 13th round, the bed breaking in two and the mortar falling upon the ground.

On the morning of the 19th the mortar fleet again opened fire at six o'clock and kept it up during the day. Gunboats came up the river to engage the forts, but were driven back. At 9 a. m. the *Maria J. Carlton* was sunk by a shot passing through the deck, and two men were wounded. The fire from the forts was rather severe on the masts and the rigging of the 1st Division. The fire of the mortar boats was excellent, as a large proportion of the shells fell inside Fort Jackson cutting up the terreplain, parapets, platforms, etc., as well as damaging casemates and threatening magazines. Some of the shells are said to have gone over, others short; though in general terms it may be said that the batteries were silenced every time the shells were concentrated on any one point.

The fuses of the mortars gave considerable trouble, and any attempt to time them had to be given up, full length being used so as to have the shells burst after they struck the ground. That was a disadvantage, as some shells buried themselves in the soft earth eighteen or twenty feet on striking, and did not do much harm except by demoralizing the men. Of the guns in the fort there were disabled, 1 10-inch and 1 8-inch columbiad, 1 32-pounder and 1 24-pounder as well as 1 10-inch siege mortar. Two rifled 32-pounders in the water-battery were disabled. The bombardment continued regularly and was kept up all night. Failures again were made in sending down fire barges.

On April 20th the bombardment was kept up, although the supply of ammunition began to grow short and steamers had to be sent down to bring up a fresh supply to the mortar fleet. Some occasional shots were fired from the gunboats. The wind was high and it was raining in the forenoon. No fire barges were sent down the river, and, as a result, that night between eleven and twelve o'clock under cover of the heaviest shell fire so far, two of the Federal gunboats went up in the darkness and attempted to cut through the chains of the raft and drag off the schooners. A heavy fire was directed upon the vessels which caused them to fall back, but not until they had in part, at least, accomplished their mission, for the raft after this could no longer be regarded as an obstruction.

The next day firing was kept up, and several guns in the forts were disabled; some of them, however, were later repaired. Fort Jackson at this time was in need of extensive repairs everywhere. The *Louisiana*, an iron clad steamer, came down from above the forts and it was expected to make repairs under cover of her heavy guns.

The fire from the forts upon the head of the 1st Division of the mortar fleet was very rapid and troublesome. Some 125 shots fell close to the vessels in an hour and thirty minutes, without, however, doing any damage beyond hitting the *Para*, the foremost vessel, cutting up her rigging and spars. The *Norfolk Packet* also had her rigging and cross trees cut away by the fire, and her deck pierced.

The divisions, on account of the hard and arduous duty, were divided into three reliefs of four hours each, one division firing about 168 times a watch, or, altogether during twenty-four hours, some 1500 shells.

The fire of the mortars at this time was so intense that it was reported that windows were broken at Balize, thirty miles away, and men and officers were so worn out that on one vessel they would be lying fast asleep on deck while a mortar on the vessel next to them was still firing.

On April 22nd the Confederate military authorities tried hard to induce the naval commander to move the *Louisiana*, a vessel carrying 16 guns of heaviest caliber, below the raft obstruction, so as to bring this ship's fire to bear upon the mortar fleet; but this was not done, as the naval officers did not consider the ship in proper condition to meet the Federal vessels, due to its incomplete condition, the vessel being regarded simply as a floating battery. Fort Jackson was still being subjected to the heaviest fire from the 13-inch mortar shells, for, although Fort Saint Philip fired upon the Federal vessels, the main attention of the Federals was given to Fort Jackson. The bombardment was kept up day and night. The Confederate fire was mostly used in shelling the point of woods from both forts, and apparently with good results, as the mortar fire slackened towards evening. The casemates of the forts were much cut up by the Federal fire. Little or no success again attended the sending down of fire barges.

After a bombardment now lasting several days Commander Porter began to despair of taking the forts and to lose confidence in the mortars; but, a deserter coming in from the forts and reporting the havoc and demoralization so far created in them, the fire was kept up and never flagged to the end.

During these three days of fire the only damage done to the armament of the forts was caused by a shell striking a platform of a 24-pounder in a salient near the main magazine; but not even that 24-pounder was rendered useless.

The next day, April 23rd, was warm, clear, and cloudless. The Confederates saw that no relief could be expected from their fleet, so the entire force was turned out to repair damages, the work going on under heavy fire from the Federal vessels. The bombardment continued without intermission till noon, then slackened, and the Confederates saw every indication of exhaustion on the part of the mortar flotilla and expected that the tactics of the Federals would necessarily be changed into an attack by broadsides from the larger ships. It was again suggested that the *Louisiana* be sent further down, but her commanding officer again objected.

Fort Saint Philip did not fire at all this day.

On the 23rd also Commander Porter urged Flag-Officer Farragut to commence the attack with his ships at night, as he feared the mortars would not hold out.

So then Farragut, after seeing that six days' incessant fire failed to reduce the forts, determined to attempt their passage with his whole fleet, excepting that part under command of Porter.

A meeting of all the captains was called, the matter was deliberated, and Flag-Officer Farragut issued the necessary orders.*

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* See page 162 and diagram page 166, Vol. 18, Series I, *Official Records of the Union and Confederate Navies*, for order and disposition for attack.

It was originally contemplated to advance to the attack in two columns abreast, each engaging the fort on its own side and that only. On second thought, considering that in the darkness and smoke vessels in parallel columns would be likely to foul each other and that the fleet might be thrown into confusion, the plan was changed and it was directed that the starboard column advance first, its rear vessel to be followed by the leading vessel of the port column, thus bringing the whole fleet into single line ahead.* Besides, the leading division in going up the river was ordered *not* to use their port guns and the flag-officer's division *not* to use their starboard guns in ascending the river, for fear of firing into each other.

It was also decided that, in case the forts were not reduced, and yet a portion of the fleet had gotten by them, that a land attack was to be made by General Butler landing on the gulf side in rear of the forts and attempting to take Fort Saint Philip by storm and assault, the bombardment being kept up by the fleet. In accordance with this plan, General Butler and his transports lay off Sable Island, landing some troops there, some twelve miles in rear of Fort Saint Philip, but yet the nearest point having sufficient depth of water for his transports.

Several vessels belonging to Commander Porter were sent up the bayou in rear of Fort Jackson in an attempt to cut off the garrisons of the forts.

On the 23rd orders were issued that the steamers belonging to the mortar fleet were to take position and enfilade the heavy water battery which commanded the approach to the forts. The vessels were to move up when the flag-officer weighed anchor and the fleet was under way.

No fire barges were sent down the river this night, and everything was in absolute darkness. The mortar vessels kept up a bombardment, which, as the time set for the run-by approached, grew more furious.

At 3.30 a. m., April 24th, the Federal vessels got under way, moving on the forts in accordance with orders previously issued.

Five vessels attached to the mortar fleet comprising the *Harriet Lane* (leading), the *Westfield*, the *Owasco*, the *Clifton*, and the *Miami*, moved up and took position under the batteries designated, the leading vessel 500 yards off and the others closing up as the fire commenced. These vessels kept their position and did not fall back till the last of the fleet, *i.e.*, of Farragut's ships, had gone by.

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* Mahan, *Gulf and Inland Waters*, page 71 *et seq.*

The Confederates saw the Federal vessels in motion and thought of preparing a strong demonstration against them with fire rafts; but suddenly seeing the fleet coming on making a rapid rush in column of twos in echelon, and realizing that the broken and scattered raft was no longer an obstacle and that the only resistance that could be offered was the fire of the forts, the Confederates made no demonstration.

The mortar fleet at this time was firing furiously and the river was illuminated by exploding shells.

The vessels came on in two columns, the right column, 1st Division, in the following orders:

Cayuga, Pensacola, Mississippi, Oneida, Varuna, Katahdin, Kineo, Wissahickon.

The vessels in the left column, 2nd Division, were:

Hartford, Brooklyn, Richmond.

The 3rd Division following, comprised:

Sciota, Iroquois, Kennebec, Pinola, Itasco, Winona.

The vessels moved so as not to interfere with each others' broadside and in going by delivered broadside after broadside of shot and shell into the forts.

Officers and men in the forts stood by their guns and opened up at their longest ranges with shot and shell, fighting their batteries till the Federal fleet got by and was out of range.

The absence of light on the river, together with the smoke of the guns, made the darkness so intense that scarcely a vessel was visible, and in consequence the gunners in the forts were obliged to direct their firing entirely by the flashes of the Federal guns.

The run-by was of short duration, occupying some seventy minutes, although it had been estimated that it was to be done in forty-five minutes.

It was said that not half of the attacking vessels got a chance at the Confederate works. The river was too narrow for more than two or four vessels to act to advantage and, besides, there was danger of the ships' firing into each other. The smoke was so dense that it was only now and then that one could see anything but the flash of cannon and fire rafts that were pushed down the river.

During the action a fire raft reached the *Hartford* which, in an effort to avoid it, was run ashore and set ablaze on the port side; the fire, however, was soon put out and the vessel again backed off, all the time keeping up its fire against the forts.

Finally the fire slackened and the smoke cleared off, when the *Hartford* found itself above the forts.

Admiral Farragut in his report says:

> As we approached the locality [of the two forts] I tried to concentrate the vessels but soon saw that we must take a raking fire for two miles, so we did not mince the matter but dashed directly ahead. They permitted us to approach within a mile and a quarter before they opened up on us.

The Confederate vessels at the time of the run-by were in close order on the eastern bank of the river above the *Louisiana*, which was near Fort Saint Philip, and in the following order: *Louisiana*, *Warrior*, two river defense boats, *McRae*, *Governor Moore*, *Manassas*, three river defense gunboats. The *General Quitman* lay on the opposite side of the river above Fort Jackson.

The first intimation that the Confederate fleet had of an attack, was the sudden heavy and general bombardment about 3:30 a.m. between the forts and the attacking fleet. After ten or fifteen minutes the first vessel of the Federal fleet was discovered coming abreast of Fort Saint Philip and opening up on the fort with its bow guns, the rest of the fleet following.

The *Louisiana* brought its three bow guns (1 7-inch rifled gun and 2 9-inch guns) into action as well as its three broadside guns (1 32-pounder rifled gun and 2 8-inch guns), all that could be brought to bear. The vessel was moored on the river bank, so the port guns could not be used. The *Louisiana* fired only twelve shots.

The *Manassas* was abandoned and set on fire and drifted down the river in a sinking condition; the *McRae* was considerably cut up by grape and shot, after having been heroically fought. The *Resolute*, having run ashore a mile above the forts, ran up a white flag, but was prevented by the prompt action of the *McRae* from falling into the hands of the Federals. The *Warrior* was run ashore and burned on a point just above Fort Saint Philip. The *Mosher*, *Music Belle*, and *Algerine* in charge of fire barges were destroyed, as was also the *Star*.

The *Stonewall Jackson*, *Governor Moore* and the *General Quitman* were all destroyed.

The *Defiance* was the only Confederate vessel saved of the river fleet.

After this action the sea power of the Confederates at this point was practically wiped out. Eleven vessels were captured or burned.

At Fort Saint Philip we have another view of this run-by. There at 3:30 a.m., the men manned their guns, but could see no vessels, the first evidence of the Federal force being the reply to shots from Fort Jackson. The gunners were ordered to fire by the flashes of the Federal guns, but the fire was too high and passed over the ships.

Immediately after this the fleet came on, seemingly passing in pairs, and the fire from the Confederate guns was now rapid and was thought to be accurate; but after the first discharge the smoke almost hid the vessels from sight and the Confederates were obliged to judge by the flashes of the ships' guns. As to the effect of the fire it was impossible to determine, owing to darkness and smoke.

The vessels passed close to the guns of Fort Saint Philip, taking advantage of the eddy which runs up with considerable force, and it was found impossible to get more than one or two shots at any one vessel, they passed with such rapidity.

Thirteen Federal vessels out of seventeen got by the forts, these being the *Hartford*, *Pensacola*, *Richmond*, *Brooklyn*, *Mississippi*, *Oneida*, *Iroquois*, *Cayuga*, *Wissahickon*, *Sciota*, *Kineo*, *Katahdin*, and *Pinola*. The *Winona*, *Itasca*, and *Kennebec* failed to get through. The *Varuna* was sunk.

The vessels which got by came to anchor at or below the quarantine station six miles above the forts, where they remained till about 10 a.m., when they passed up the river, with the exception of two that were left on guard at the station.

Shortly after the fleet got under way, a gunboat from below went up with a flag of truce and verbally demanded the surrender of the forts in the name of Commander Porter. This being refused, the bombardment was again commenced and lasted from about noon till sundown, some four hours, when it ceased altogether. The entire mortar fleet and accompanying vessels, except six gunboats, then got underway and passed down the river. During the night everything was quiet.

On April 25th there was no attack on the forts below, vessels of Porter's fleet remaining in observation, and the day being spent in the forts repairing damages, shifting guns about, and making preparations to be ready when the attack should be renewed.

Farragut's fleet continued up the river and engaged the Chalmette and McGhee batteries, which action was soon over, the last of the Confederate batteries being passed about 11 a.m. At 5 p.m. that day, General Lovell, the Confederate commander, gathering what supplies and men he could take with him, abandoned New Orleans, turning its affairs over to the civil authorities, whereupon the mayor of the city capitulated.

Marines were landed to preserve order, the city being in possession of a mob, and on May 1st General Butler arrived with 15,000 troops and took charge.

On April 26th the forts learned that New Orleans had surrendered, that troops were being moved up from Sable Island, and that men were being landed at the quarantine station above Fort Saint Philip with the evident intention of hemming in the works from above.

On the 27th a written demand was made that the forts surrender and it was refused.

The spirit of the Confederate troops up to this time and throughout the action and bombardment had been cheerful and courageous, but now a change came over them, rumors having reached them that the city above had surrendered. Everything remained quiet, however, until about midnight, when the garrison of Fort Jackson revolted in mass, seized the guard, and commenced to spike the guns, while many of the men (some 250) left the fort with all their arms. These later surrendered to General Butler's pickets. They stated that their officers intended to hold out as long as possible or while provisions lasted, and then blow up the forts; but that the city having surrendered and the Federals having gotten in their rear, they, the men, thought there was no further use of fighting.

Every endeavor was made to repress the revolt among the men remaining in Fort Jackson, but it was not successful; so there was no further use to think of fighting. Moreover, it was seen that no help could be expected from Fort Saint Philip, as it was itself threatened and likely to be attacked; so on the next morning, April 28th, although none of the men in Fort Saint Philip had revolted or deserted, yet, as a result of a conference between the two forts it was thought best to surrender on terms previously rejected.

The opening of the lower Mississippi was now an accomplished fact.

CASUALTIES

Casualties in the forts were:

Fort Jackson	9 killed,	35 wounded
Fort Saint Philip	2 ”	4 ”
	—	—
Total	11 ”	39 ”

There are no reports of the battery commanders in the Records, so a detailed Confederate account cannot be obtained.

Injury to Fort Saint Philip by Federal fire was slight, as only one mortar was fired at it, it being far away from the mortar fleet. One 7-inch gun burst from the explosion of a shell in its bore near the muzzle; 1 24-pounder was broken in two by being struck by a solid shot; 1 8-inch columbiad was temporarily dismounted; and several carriages were more or less damaged.

Because of the little damage done Fort Saint Philip, it was from its guns that the attacking fleet received most damage.

Fort Jackson was more severely handled. The mortar fleet, it is estimated, threw some 6000 or 7000 13-inch shells into the fort, expending in all, according to the report in the Century *Battles and Leaders of the Civil War* 16,800 shells, or 2800 shells per day for a period of a little over five days.

In detail, the damage at Fort Jackson consisted of: four bastion casemate guns disabled; eleven gun carriages struck; some thirty traverses injured; a large number of injuries on the western side of the outer curtain, where twenty out of thirty-nine guns were more or less injured; ramparts of the fort severely damaged on every side, particularly on the two northern sides; several of the entrances from the parade ground under the ramparts converted into masses of ruins, some of them being one-third choked with debris; casemates cracked from end to end, one of the bastion casemates having its roof broken through in three places and its walls badly cracked; entrances to the casemates nearly all damaged, roofs being cracked and masses of brick thrown down or loosened; all buildings destroyed by fire or shell; and the two western bastions and the citadel badly cracked in many places, eighty-six shot and splinters striking its faces.*

In addition to the work being much injured, the levee about it was cut in over a 100 places, water entering the casemates.

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* For further detailed account see *Official Records of the Union and Confederate Armies*, Series I, Vol. XV, page 429 *et seq*, and plan of fort, page 434.

The credit of reducing the forts was given by the men to the mortar fleet, for although the surrender did not immediately follow the bombardment, yet it is probable that the awful mortar bombardment did demoralize the garrison.

The actual loss of life was slight and one writer has calculated that there were sixteen tons of metal thrown for each man killed or wounded. Up to the 22nd of April the entire Confederate garrison is reported to have consisted of some 1100 men, and up to that time four had been killed and fourteen wounded. This small loss of life was perhaps due in part, at least, to the fact that the men could see the mortar shells coming and would take cover in time; then, too, the soil upon which the forts stood allowed the shells to sink, sometimes as much as twenty feet, before exploding.

General Butler states in his reports that the forts were substantially as defensible as before the bombardment, especially Fort Saint Philip, it being quite uninjured, fully provisioned, and well supplied with ammunition. But most of the damage had been repaired by that time by theConfederates.

The mortar fleet and its flotilla had one killed and twenty wounded.

Of Farragut's fleet the *Hartford* was hit 32 times, about half in the rigging and half in the hull, and had 3 men killed and 10 wounded and 3 guns disabled. The *Cayuga* was struck 42 times and had 6 wounded. The *Brooklyn* was under fire an hour and a half and suffered the greatest loss, having 10 killed and 26 wounded. This vessel was struck in all 39 times. The *Richmond* had 2 killed and 4 wounded, receiving 6 hits in the hull and many in the rigging. The *Pensacola* was under fire about 2 hours and had no killed nor wounded; she received 9 hits in the hull. The *Mississippi* received 10 hits, 8 of which passed through the ship. The *Oneida* sustained no damage. The *Varuna*, rammed by the Stonewall Jackson and sunk, had 3 killed. The *Katahdin* received 2 hits only, which was attributed to the speed of her run-by and to the fact that the shots from the forts went over. The *Kineo* had 9 hits and 1 killed and 8 wounded. The *Wissahickon* had 2 wounded, receiving 5 hits; this vessel was low in the water. The *Sciota* had 2 men wounded. The *Iroquois* had 8 killed and 24 wounded, and was badly injured in the hull. The *Pinola* received 12 hits and had 3 killed and 8 wounded. The

Itasca had 3 wounded, receiving 14 hits and being severely damaged; in a sinking condition she fell back to the mortar fleet. The *Winona* had 3 killed and 5 wounded; she was compelled to fall back to the mortar fleet. The *Portsmouth* had to fall back, as she could not get her guns to bear on the forts.

In general terms it may be stated that Farragut's vessels were struck only 23 times in their hulls from shots from Fort Jackson, while they received their greatest damage from Fort Saint Philip, which illustrates the advantage derived from the mortar fleet's keeping Fort Jackson engaged.

The entire Federal loss was 36 killed and 123 wounded; and the total Confederate loss is estimated as from 1000 to 1500, though the losses at the forts were only 11 killed and 39 wounded, as stated.

EXPENDITURE OF AMMUNITION

Fort Saint Philip is reported to have expended:

675	8-inch solid shot.
171	8-inch shell.
13	13-inch shell.
142	10-inch mortar shell.
120	Shot, shell, and grape from the upper water-battery.
470	Shot, shell, and grape from the lower water-battery.

From the Federal mortar division the usual rate of fire was at ten minutes interval, sometimes twenty minutes; but on the 24th of April, the day of the passage of the forts, the *Norfolk Packet* is reported to have fired twenty-eight shells at the rate of one every two minutes and forty seconds—the greatest rapidity of fire attained.

The heaviest charge of powder used by the mortar division was twenty-three pounds, which was required to reach Fort Saint Philip at a range of 4710 yards against a fresh wind.

In the 1st Division of the Federal fleet four vessels fired a total of 1512 shells, using 30,994 pounds of powder.

In the 2nd Division some individual vessels expended more than 300 shells.

OPINIONS OF CONFEDERATES

In concluding the statistics of the capture of New Orleans, it is interesting to consider what the immediate Confederate commanders, Generals Lovell and Duncan say.

General Lovell attributes the loss of New Orleans to the following:

1st. Want of a sufficient number of guns of large caliber.

2nd. Unprecedented high water which swept away the obstructions upon which much reliance had been placed, to prevent, in connection with the forts, the passage of a steam fleet up the river.

3rd. Failure, through inefficiency and want of energy, of those who had charge of the construction of the iron clad steamers *Louisiana* and *Mississippi*, to have them completed in time to take the place of obstructions, and the refusal of the officers in charge to have the *Louisiana* placed as a battery as desired by the Confederate commander.*

General Duncan says:

> Great as the disaster is, it is but the sheer result of that lack of cheerful and hearty cooperation from the defenses afloat which we had every right to expect and to the criminal negligence of not lighting up the river at night when the danger was imminent and the movements of the enemy absolutely known almost to the hour of the final attack. Except for the cover afforded by the obscurity of the darkness I shall always remain satisfied that the enemy would never have succeeded in passing Forts Jackson and Saint Philip.†

COMMENTS

1. This is a typical example of a run-by carried out by a determined naval commander who was willing to take the risk.

2. Success was due to doing the unexpected, as apparently the Confederates did not seriously contemplate an attack on New Orleans from that quarter.

3. There is here illustrated lack of preparedness and the fact that war material cannot usually be improvised.

4. There was lack of cooperation between the defensive forces afloat and those ashore, and, besides, a fatal division of authority over the floating defenses.

5. There was lack of appreciation of the value of the obstruction placed across the channel.

6. There was no system of mines to close the river.

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* "I had frequent occasion to regret that it was impossible to give me control of the defenses afloat as well as ashore. A single controlling head might have made all the resources more available and efficient in working out the desired results." (See *Official Records of the Union and Confederate Armies*, Series I, Vol. VI, page 518 *et seq.*)

Official Records of the Union and Confederate Armies, Series I, Vol. VI, 14.

7. There was no illuminating service, except that furnished by fire rafts, and those were not properly used.

8. This action emphasizes the necessity for rapid fire guns and a fire control system that allows a battery to open fire at once.

9. Experience had here indicates that even a partial run-by accomplishes the purpose of the attackers, for the moral effect of an enemy in rear was sufficient to cause the capitulation of the forts.

REFERENCES

Official Records of the Union and Confederate Armies, Series I, Vol. VI, pages 503-656, Series I, Vol. XV, pages 412-436, Atlas, and General Index.

Official Records of the Union and Confederate Navies, Series I, Vol. XVIII, pages 131-356, and 434-446.

Century *Battles and Leaders of the Cival War*, Vol. II, pages 14-103.

Scribners Series *The Gulf and Inland Waters*, Mahan, Chapter III, pages 52-92.

A History of the War of Secession, Rossiter Johnson, pages 111-126.

Monitor and the Navy under Steam, Frank Marion Bennett, pages 151-158.

Lectures on the American Civil War, James Ford Rhodes, page 112.

Artillery Notes No. 28, pages 38-43.

History of the Navy, Maclay, Vol. II, pages 306-350.

THE ERRORS OF INTERNAL-BASE RANGE-FINDERS

By Captain GLEN F. JENKS, (C. A. C.) Ordnance Department

In the service internal-base range-finders, ranges are measured by establishing coincidence between the images formed separately by the two objectives. This coincidence is secured by moving a small deflecting prism longitudinally along the axis of one of the objectives. This prism deflects the pencil of rays transmitted by one objective by an amount equal to the parallax of a distant target. The parallax is the angle at the target subtended by the range-finder. Its amount varies directly with the length of the range-finder. The smallest difference in parallax which can be detected varies with the power of the telescope system and with the sensitiveness of the observer's eye. The human eye is capable of observing as distinct entities objects separated by 30 seconds of arc. With the aid of a telescope the angle of resolution becomes $30''/m$, m being the power of the telescope system. Thus an error of $30''/m$ made in aligning the image in an internal base range-finder cannot be detected by the eye. Operators making perfect observations may make angular errors of this amount. It will be noted, however, that the angle of resolution of eyes of different observers vary, and that one may increase his accuracy of observation through practice.

In the figure, let b represent the base of an internal-base range-finder and β the angle at the target, of range R, subtended by the instrument. α is the angle of resolution of the telescope as limited by the eye. The difference between the ranges R and R' is the smallest that can be detected.

β and α being small,

$$R = b/\beta$$

$$R' = \frac{b}{\beta + \alpha}$$

$$R - R' = b\left(\frac{1}{\beta} - \frac{1}{\beta + \alpha}\right)$$

$$\varDelta R = -\, b\left(\frac{+\,\alpha}{\beta\,(\beta + \alpha)}\right)$$

The product $\alpha\,\beta$ being of the second order, and neglecting signs,

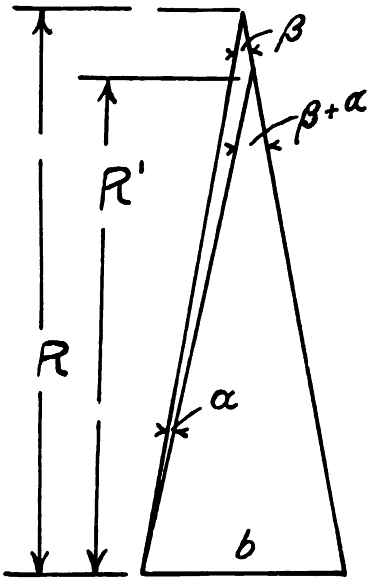
$$\varDelta R = \frac{\alpha\, b}{\beta^2} = \frac{\alpha}{b}\, R^2$$

Using $\alpha = 30/m$, $b = 3$ yards, and $m = 30$,

$$\varDelta R = .0000016\ R^2$$

which is equivalent to range errors as follows:

Range (yds.)	1000	2000	4000	6000	8000	10000	15000
Error "	1.6	6.	26.	58.	102.	160.	360.



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It will be noted that as α is + or −, these errors are plus or minus. In perfect work, these errors from the true range should not be exceeded on any observation, provided that the instrument is in correct adjustment.

From the above, $\frac{\varDelta R}{R^2} = K$, a constant.

Now, $\frac{\Delta R}{R^2} = \Delta\left(-\frac{1}{R}\right)$

Therefore, $\Delta\left(\frac{1}{R}\right) = K$, which is independent of the range.

The fact that the error of the reciprocal of the range is constant for all ranges, affords an excellent means of comparing the accuracy of instruments and observers at all ranges. This method is used below in analyzing the records of tests.

Errors in range-finding may be classified as errors of adjustment and errors of observation. The latter, it has been shown, are angular errors independent of the range. From the nature of the instrument and the method of adjustment, it is apparent that the error of adjustment is of the same nature. In this discussion, errors causing loss or change of adjustment, e.g., those due to unequal expansion of parts, shock, etc., are neglected. They are largely eliminated, as a given series of observations is made under practically constant conditions, and extends over a short period of time. The mean value of the algebraic sum of the errors of the reciprocals is taken as the error of adjustment. The variation of the error for a single observation from the error of adjustment is the error of observation.

The uncertainty of observation claimed by the manufacturers is, expressed in error of reciprocal, .00000087, which corresponds to an angular error of $16/m$ seconds. The manufacturers claim that this error was obtained by actual practice. Whether it represents the mean or the probable error or maximum error within which good observers should keep, is not stated. It will be noted that this uncertainty of observation is but little over half of that assumed above for good observations. In shorter range-finders made by Barr and Stroud, a mean error of observation of $16/m$ seconds for a series of five observations on each of several fixed targets was not exceeded. In another series with an 80 cm. range-finder, of about 30 observations each on different fixed targets, the mean error of observation for the series was less than $8/m$ seconds. For the mean error of observation, the claims of the manufacturers appear justified.

Tables I to VI, inclusive, at the end of this article, are taken from the record of the test of the Barr and Stroud range-finder, made by the Coast Artillery Board on moving targets.

For a report of that test, see JOURNAL OF THE U. S. ARTILLERY, vol. 30, page 225.

Tables VII to XI, inclusive, were prepared from readings made during the fall of 1912 at various posts in compliance with requests for data of comparative accuracy of the Barr & Stroud internal-base range-finder and the horizontal base system.

The mean results of the Fort Monroe tests at moving targets, tabulated, are:

Number of Readings	Error of Adjustment	Error of Observation
27	−18.8	19.9
50	+18.5	18.6
50	−41.4	41.5
44	− 6.1	18.2
40	+35.8	22.4
47	+26.6	10.57
Total 258	Average 24.5	Mean 22.23

The mean results of service tests for day work only, follow:

Number of Readings	Error of Adjustment	Error of Observation
15	− 29	38
12	+ 6	38
11	+ 13	65
44	−115	44
91	+ 99.2	30.3
Total 173	Average 52.4	Mean 37.2

(Errors have been expressed in reciprocals × 10^7.)

In the Fort Monroe tests on moving targets the mean error was approximately two and one-half times greater than the error claimed by Messrs. Barr and Stroud. In the service tests the error was over four times as great. The best series recorded is one in which the mean error was one and one-fourth times that claimed for the range-finder. The probable error calculated from this series is about the same as the uncertainty claimed. In the best series of the service tests the mean error was three and one-half times that claimed.

A few series of observations on fixed targets during the Fort Monroe tests are detailed under Tables XII, XIII, and XIV. The mean errors were:

Number of Readings	Error ot Adjustment	Error of Observation
30	+ 3.4	23.7
20	+ 3.1	9.1
25	−24.2	10.95
Total 75	Average 10.2	Mean 14.5

The first of these series was probably made under poor conditions of observation. Later, on moving targets, the same observer made less than half the mean errors recorded. The mean error of the other two series approximates the errors claimed by the manufacturers. An examination of the record indicates that the range given to the nearest datum point is not correct. The accuracy of some of the other ranges given might be questioned.

The errors of observation recorded in Table III are unusually large, the error between consecutive readings being in some cases 15 times as great as that claimed as the uncertainty of the instrument. The horizontal base work with which the observations are compared, is good. On the same day, other observers made much better records. These large errors must be ascribed to the lack of skill on the part of the observer. In Table VI, the maximum error between consecutive readings is about one-fourth that shown in Table III. The record of Table VI is very good. The other records largely show lack of skill on the part of the observer.

From the records of the Fort Monroe tests, it is concluded that under the best conditions the mean error of observation on moving targets under service conditions should not exceed greatly, if at all, the error claimed by the makers, and that under average conditions the mean error of observation should not exceed .00000222 expressed in reciprocals.

In Table IX, both the mean error of observation and the first differences of the errors of observation are very large. It is possible that a part of these errors are due rather to the horizontal base or to slight inaccuracy in relocating for the internal-base instrument. Because of the large effect of such errors on the error of observation, moving targets at short range are not suitable for determining the error of observation nor the adaptability of the internal-base instrument as a range-finder at long or medium ranges.

Table X shows a similar condition of affairs. The errors of observation at the shorter ranges are very large. The large variations in the error of observation for the first readings in comparison with those of the rest of the series, indicate either very poor work of the observer at first and very good work later, or errors in the data with which comparisons are made. An examination of the first differences of the plotting board ranges indicates that the maximum accidental error is about 10 yards. This does not account for the large errors. Let us assume that a constant error of −60 yards has been made in plotting the ranges in the first column of the table. Smoothing out the first plots, with this correction the errors become as follows:

	Error assuming 60-yard error in plotted range	Variation from mean error
	−143	−96.5
	− 68	−21.5
	− 58	−11.5
	− 54	− 7.5
	− 48	− 1.5
	0	+46.5
	− 61	−14.5
	− 19	+27.5
	− 18	+28.5
	− 32	+14.5
	− 45	+ 1.5
	− 28	+18.5
	− 26	+20.5
	− 37	+ 9.5
	− 35	+11.5
	− 43	+ 3.5
	− 50	− 3.5
	− 47	− .5
	− 44	+ 2.5
	− 51	− 4.5
	− 36	+10.5
	− 38	+ 8.5
	− 42	+ 4.5
	− 34	+12.5
	− 38	+ 8.5
	− 48	− 1.5
	− 46	+ .5
	− 50	− 3.5
	− 47	− .5
	− 51	− 4.5
	− 48	− 1.5
	− 51	− 4.5
	− 50	− 3.5
	− 51	− 4.5
	− 53	− 6.5
	− 55	− 8.5
	− 53	− 6.5
	− 55	− 8.5
	− 53	− 6.5
	− 51	− 4.5
	− 49	− 2.5
	− 48	− 1.5
	− 49	− 2.5
	− 44	+ 2.5
Mean	− 46.5	±10.57

The corrected error of observation is more reasonable, showing no gradual variation from one end of the series to the other. It is improbable, from the construction of the internal-base range-finder, that this systematic error of 60 yards could exist in it. We may conclude, therefore, as probable, that the systematic error of plotting with the horizontal base line was approximately −60 yards.

The error of observation, except in 6 out of 44 observations, is now within the limit of 30″ given above. The mean error of observation is the same as that of the best series made during the Fort Monroe test. Neglecting the first reading, in making which the operator was not "settled down," the mean error of observation is approximately the error of uncertainty claimed by the manufacturer. It will also be noted that the first differences in the error of observation are within the value of $30''/m$ (reciprocal equals .0000016) except in five cases. Except for the first third of the series, the work of the observer is excellent for regularity of results. This series confirms the opinion expressed above that under good conditions the mean errror of observation should not exceed that claimed by the manufacturers as the uncertainty of this instrument.

An examination of the first difference of the last 37 observations of Table XI shows considerable variation in the speed of the target (the first difference of the range). Correcting the series of plotted ranges, it is found that the maximum accidental error of plotting is 25 yards, whereas the mean accidental error of plotting is 6 yards. Considering only these observations and the plotted ranges as given, the error of adjustment of the range finder is .00001106 and the error of observation is .000001805. Using corrected plotted ranges, the error of adjustment is .00001108 and the error of observation is .000001802. It is apparent that in an extended series of readings, errors of this magnitude in the plotting of ranges have but little effect upon the calculated errors of the internal-base range-finder. In these calculations the errors of the plotted ranges are therefore neglected.

Neglecting Table IX and using .000001057 as the error of observation for Table X, the mean errors of service tests become:

Number of Readings	Error of Adjustment	Error of Observation
15	−29	38
12	+ 6	38
44	−46.5	10.57
91	+99.2	30.3
Total 162	Average 45.2	Mean 26.22

This error of observation is very close to that of the earlier Fort Monroe tests. It does not, however, represent the best results that can be expected from the service. After the proper training of observers it is thought that the mean results will show considerable improvement. These records confirm the conclusions drawn from the Fort Monroe test.

Plate I shows the range error of observation of the 9-foot range-finder as claimed by the manufacturer (reciprocal error equals .00000087). Under the best conditions, few errors of single observations should exceed double this amount. The mean error of observation of the Fort Monroe tests analyzed are also shown (reciprocal equals .00000222). It will be noted that the errors do not correspond with the average errors given in the JOURNAL OF THE U. S. ARTILLERY, vol. 30, page 225, nor should they, as in that article the errors of adjustment and of observation have not been differentiated.

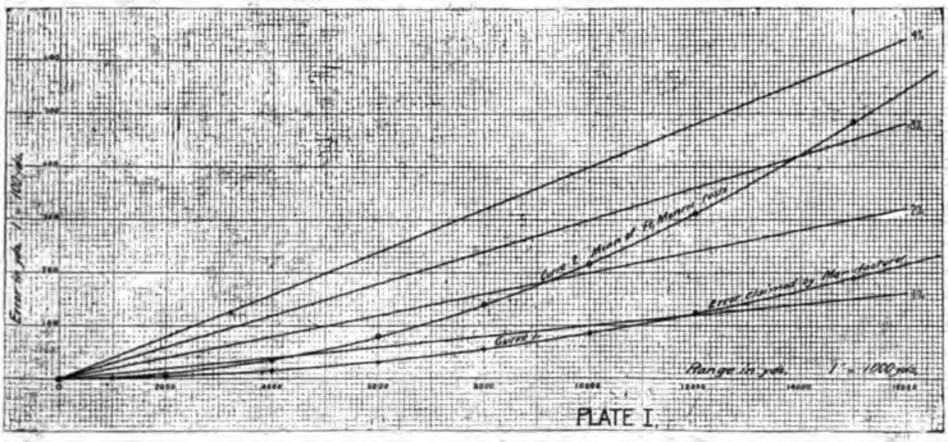

PLATE I.

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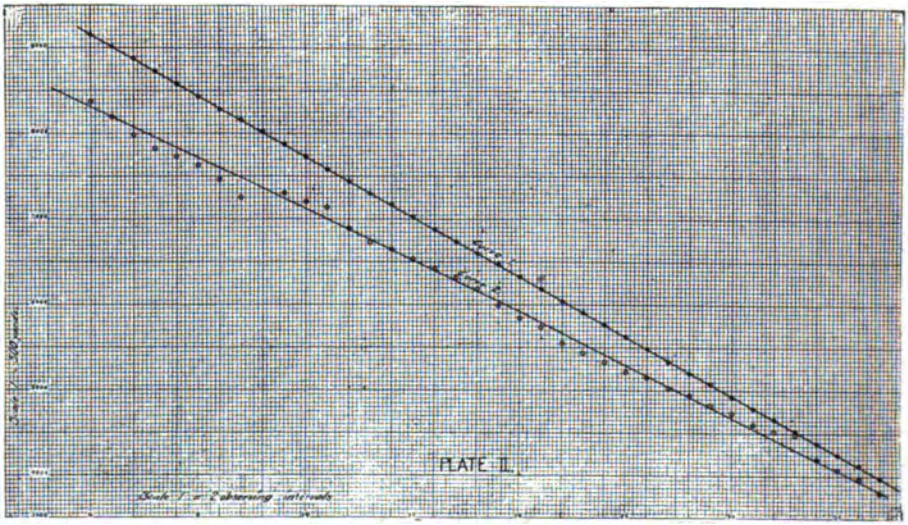
Tables XV, XVI, and XVII indicate that the error of observation during night practice is from two to three times greater than that for day work. None of the records tabulated are good. Sufficient data are not available by which to determine whether those tabulated are representative, nor is it known under what conditions they were made. It should be anticipated, however, that skilled observers will produce better results.

An examination of the tables given above shows exceedingly large errors of adjustment. In two of the three Fort Monroe tests at fixed targets which were analyzed, the error of adjustment was 40 per cent of the mean error of observation claimed for the range-finder. In one series at moving targets in the Fort Monroe tests, and in one series of service readings, the error of adjustment was 70 per cent of the mean error of observation. These adjustments were fairly good. In the Fort Monroe tests at moving targets, the average error of adjustment was nearly three times the uncertainty claimed for this range finder; and in the service tests the average error of adjustment was over four times as great. The large errors of range finding possible with a poorly-adjusted instrument will be apparent from an examination of Table XI and of Plate II. Of the error of 1860 yards in a range of 10,000 yards recorded, for example, 1280 yards is due to the error in adjustment of the instrument and 580 to error of observation.



From an examination of the errors recorded, it is reasonable to assume that the internal-base range-finder can be adjusted within a small error. It is obvious, however, that adjustment should not be made at short ranges. Any error in the range to the datum point introduces instrumental errors of adjustment which increase with the square of the range. The "infinity" adjustment described in Ordnance Pamphlet No. 1905 (Description of the Barr and Stroud 9-foot Range-Finder) should produce excellent results if carefully made and checked.

To adjust on datum points of known range, select a long-range datum point, bring the image into coincidence by means of the deflecting head, and set the range scale to register the known range. Then, without changing the scale adjustment, make ten independent observations on the given datum point and calculate the mean value of the registered ranges. Now, using the deflection head, set the scale to register the mean range. The instrument is now in mean coincidence. Then, without changing the coincidence adjustment, set the scale to register the correct range. This adjustment should be checked, preferably on other datum points. In checking on datum points of different ranges, add algebraically the reciprocals of the mean registered ranges to obtain the error of adjustment. Calculate the range equivalent of the error in reciprocals, and readjust the instrument as described above. Short-range points will preferably not be used for checking this adjustment. Greater weight may well be given to errors of long-range datum points than to those of medium or short range.

To minimize the error of observation while adjusting instruments, care should be taken to select suitable datum points upon which to adjust internal-base range-finders. The object selected should be preferably of small angular width, should stand out in sharp contrast to its surroundings, and its edges should be distinctly defined. The edge of a building or an object inclined to the vertical is not suitable. A vertical staff or pole makes an excellent datum point.

The range to all datum points from the range-finder station should be accurately known. This is especially true for datum points of short and medium range. However, because of the greater chance for large errors of adjustment, short-range datum points should not be used wherever it is possible to secure long-range points.

On Plate II is plotted as a function of time, from the data for the last 37 observations given in Table XI, the corrected plotted ranges (Curve 1), the range-finder ranges, and their mean curve (Curve 2). The error of adjustment is the departure of Curve 2 from Curve 1. The variation of individual points from Curve 2 is the error of observation. An examination of the curves will illustrate the law that errors of range-finders, both of adjustment and of observation, increase with the square of the range. Curve 2 also illustrates the tendency of observers to make successive errors of the same sign. This is natural, as the observer unconsciously rotates the deflecting head by approximately equal amounts in successive observations. For smooth tracking, he is taught to do this. An excellent example of this tendency is shown in the later part of the table on page 53.

In predicting from internal-base range-finder readings, large errors are possible. For example, if a prediction for one time interval is made, based upon the ranges for Intervals 6 and 7 (Plate II), the predicted range will vary 350 yards from the mean range-finder track. Predictions for one or two intervals, based upon Times 5 and 7, will result in almost as large errors. If a mean curve is drawn through the first eight observations and the prediction is made on the mean curve, the error of prediction will be materially reduced. In either case it will be considerable, due to the increasing plus error of observation. After Time 10, predictions on the mean curve may be made with greater accuracy.

A study of this track emphasizes, in the use of internal-base range-finders, the necessity for:

(1) Accurate adjustment of the range-finder.

(2) Plotting either the range-azimuth or the time-range relation. This renders it possible to eliminate largely the error of observation.

(3) Basing predictions upon the mean track, rather than upon the latest two or three observations.

(4) Recognition of the tendency of observers to make successive errors of the same sign. This tendency will be apparent from an examination of the tables.

(5) Taking observations and plotting at more frequent intervals.

The probable error of the mean of several observations is less than that of a single observation. Besides, because of the insensitiveness of the eye, the deflecting prism may be translated a small amount without affecting the apparent coincidence. The observer trained to move the deflecting head by approximately equal amounts for range changes during the time interval, tends to change the position of the deflecting head either too little or too much. These variations will accumulate until, for the given movement of the prism, lack of coincidence is apparent to the eye. Now, upon the establishment of coincidence, the error of observation will be changed, with possible variation of its sign. The oftener the observation is made, the oftener the probable change of sign of the error and the greater the accuracy of the mean plot. Especially on curved courses will frequent readings be of value.

The frequency of observation will be limited by the eye-fatigue of the observer and the time required for plotting and predicting. The interval should be as small as practicable.

(6) A knowledge on the part of the plotter of the probable error of observation at various ranges, in order that he may better judge the reliability of data.

(7) Making predictions for as short intervals as practicable:

The predicting interval should not of necessity be the same as for horizontal base systems and should be fixed by the time required to obtain the range of the set-forward point and to set the gun for that range. This is important, because of the tendency to make errors of observation of the same sign.

The plotting of the azimuth-range relation for internal-base range-finders is objectionable for the reasons:

(1) Independent instruments are required. Because of the method of use of the range-finder, it is impracticable to add cross wires to measure the azimuth. Of course, external base lines require the use of two instruments properly coordinated. If the internal-base range-finder is used with batteries not equipped with horizontal base lines, it is desirable to reduce the system of observation and plotting to its simplest terms. The deflection travel must be measured, but this may be obtained direct from a suitable instrument with azimuth travel scales or otherwise. Unless other commensurate advantages are gained from plotting the range-azimuth relation, it seems unwise to burden the plotter with what may be obtained otherwise.

(2) The plotting of a *mean* track is cumbersome. The present plotting board material is not well adapted for this work. Service predicting devices are based upon the use of successive intervals or those once removed. Predicting from a mean track would require the actual locating of points on the mean track or the designing of predicting devices adapted therefor. The first is undesirable, both as the plotter is now overworked and longer predicting intervals would be necessary. Rather, the system of plotting should be such as to permit the reduction of the observing and predicting interval. The latter appears impracticable, due to mechanical difficulties.

(3) The difficulty attending the use of the time element in predicting for a set-forward point, especially due to the variable time of flight. Separate predicting instruments are required

which are not well suited for points located by internal-base range-finders.

(4) Greater time required in setting arms for azimuth and in plotting and predicting, locating the set-forward point and bringing up the gun arm to read the range of the set-forward point.

The plotting of the range-azimuth relation is advantageous in case of a target moving on a curved course. The reliability of a reading may be better checked by the travel in azimuth during the observing interval. However, at its best, plotting a mean curve of range-azimuth relation for a target moving on a curved course will require greater skill than can be anticipated. With the same skill a good estimate of the probable change of travel during the predicting interval may be judged on a range-time board by information received from the observer as to the turning of the target.

This method is advantageous for emergency conditions in batteries equipped with plotting boards, in that it makes use of existing material.

Relocation for displacement of the range-finder from the gun can be made without difficulty.

The advantages of plotting the time-range relation are:

(1) Greater rapidity possible. Readings from one instrument only are required to be set off. The time coordinate may be set off just before the range is transmitted. The targ may be attached to the primary arm, set to the given range, and the point plotted by pushing a plunger. Predicting may be quickened by being made semi-automatically. This is practicable because of the use of time as a coordinate.

(2) Simplicity of predicting on a mean track by special means to be described below.

(3) Simplicity in using the time element for the set-forward point, as time is used as a coordinate in plotting.

(4) Greater accuracy resulting from greater rapidity. As the time required for operation is less, the predicting interval may be decreased. Changes in the speed or in the course of the target will therefore have less effect.

The objections to the use of the time-range relation in plotting are:

(1) Corrections for displacement of the range-finder from the gun are difficult to make.

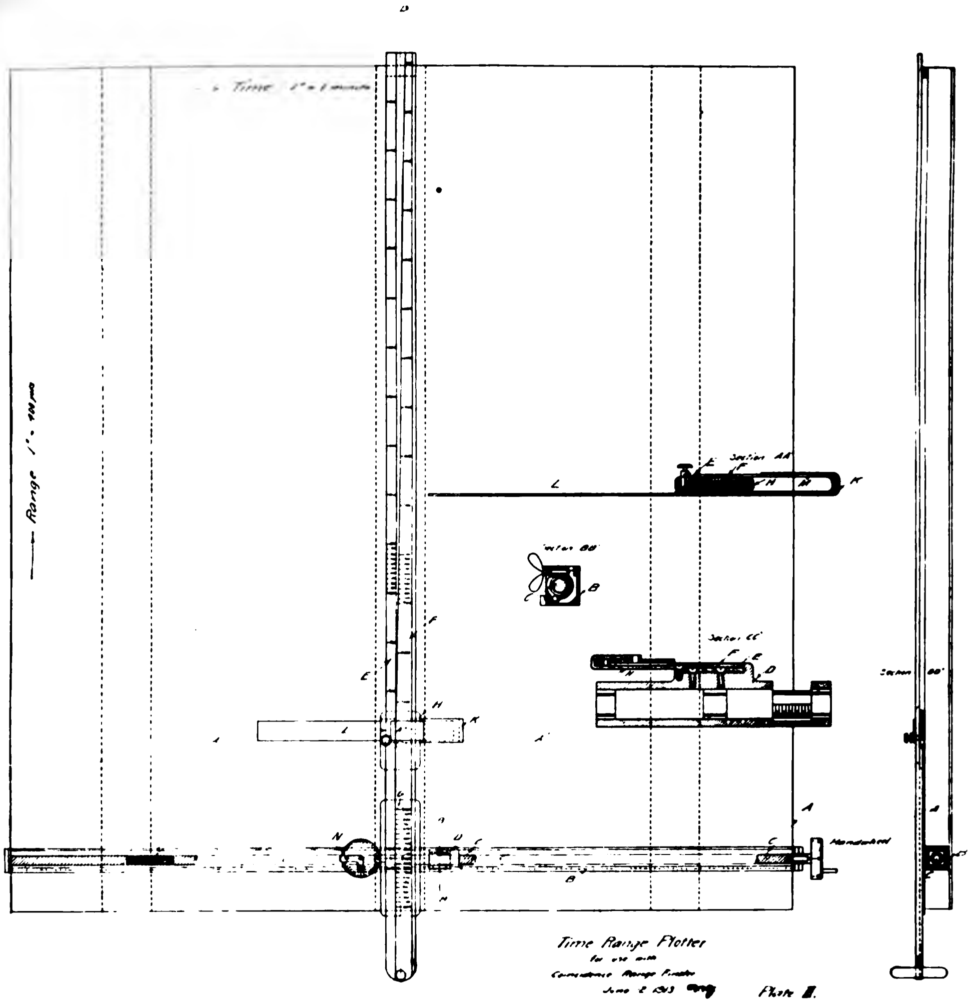
(2) The position of the target is not plotted and the

change of range cannot be checked with the change of position.

(3) Independent instruments are required for obtaining and correcting azimuths for Case III.

Plate III shows the general construction of a range-time board designed to meet the requirements of plotting and predicting from range-finder range readings. The board consists of a rectangular plotting board (A) in which is inserted a metal guide (B). Measurements parallel to the guide are time, those normal are ranges. In the guide (B) is translated by a worm (C) the carriage (D). The handwheel at the end of the worm is graduated in convenient time intervals. The bearing between (C) and (D) is adjustable for wear and may be quickly disengaged for rapid movement of (D) from one side of the board to the other. To (D) is fixed a range arm (E) in which slides a gun arm (F). The range correction scale (G) is provided for setting off range corrections in the usual manner. On the fiducial edge of the gun arm (F) is machined a time of flight curve. Both E and F are graduated to read ranges. Beneath (E) is a movable slide (H) which carries a plunger with pin point and spring (used to plot in the same manner as the targs for 360° mortar plotting board) and to which is pivoted a predicting bar. The predicting bar consists of a metal frame (K) in which are inserted two thin transparent celluloid strips (L) and (M), (L) lying on the board and (M) over the gun arm scale. The index for the range corrector scale (G) may be made adjustable to correct for displacement of the range-finder from the gun. A device (N) for this purpose is shown. The correction made is approximate only, but for displacements up to 300 yards the error is not great.

To operate the device: set (D) to correspond to the time; move slide (H) to the range-finder range read on arm (E); rotate the predicting bar so that it is not under the plunger; and press the plunger. Move the carriage by the worm handwheel to the next time and proceed as before. To predict from a mean range curve, set the predicting bar so that its fiducial edge lies in a mean position between the observation points, and at the intersection of the fiducial edge (M) with the fiducial edge of the gun arm (F), read the range of the set-forward point which is predicted for the prediction interval plus the time of flight. The width of the range arm (E) corresponds to the predicting interval. The distance from the nearer edge of the arm (E) to the time of flight curve on the arm (F) corresponds to the time of flight. The prediction interval shown is 30 seconds,



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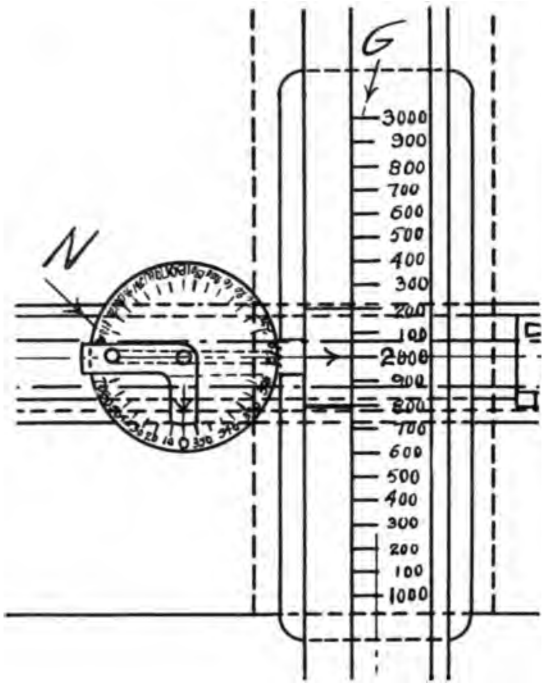

Details of the range corrector scale (G) and device (N) for adjusting its index

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but it may be decreased. The mean track may be plotted by a pencil line.

If desired, a separate correction scale for range correction from observation of fire may be provided.

For rapid-fire guns it may be found advisable to use logarithmic range scales on arms E and F in order to permit the use of range percentage corrections. These scales may easily be graduated and used in this manner. Logarithmic scales are already used on the range correction slide rule for mortars. The objection to this is the error of prediction. Assuming a prediction interval of 15 seconds and a target changing range at the rate of 800 yards per minute, the error of prediction due to the use of logarithmic scales would be 18 yards at 2000 yards range and 10 yards at 4000 yards. These errors are small and may be neglected, provided that compensating advantages accrue.

The range errors due to changes in ballistic coefficient, atmosphere, wind, and muzzle velocity approach closer to a percentage correction than to a flat correction. Errors due to range-finding vary with the square of the range, which is greater than a percentage correction. Thus, percentage corrections will give more accurate results than a flat correction, and the diminution of error in using percentage corrections will ordinarily be much greater than the error introduced by predicting on a logarithmic scale. For these reasons, logarithmic scales are preferred for use with rapid-fire guns.

With logarithmic scales it may be found necessary to modify the details of the correction scale, or to change its location; but no serious difficulties in design are anticipated.

For successful prediction there must be used a mean-range curve based upon the greatest practicable number of observations. It is believed that with the service plotting board, the rate of observation will be limited by the plotting board rather than by the eye-fatigue of the observer. With the range-time plotter, which is simpler and quicker to operate, more frequent observations may be utilized in predicting the set-forward point. In general, this advantage and that of simplicity, it is believed, outweigh the advantages of the plotting board for this class of work. The objection to the method of correcting for displacement is not serious, as internal-base range-finders are ordinarily not far from the gun. The other objections are believed to be outweighed by advantages obtained. The cost of range-time boards should not equal that of plotting boards.

For 6-inch and smaller guns, this range-time system of plotting can be used to advantage, especially because of its facility, and consequently of its accuracy. It is believed that a more rapid method of predicting than practical with the plotting board is required. The use of ranges from the range-finder without smoothing, admits of too great errors. Corrections may be set off more easily on the range-time plotter than by the gunner, who has no special means for the purpose.

For 3-inch and 4.7-inch rapid-fire guns, the use of a device by which the effect of the error of observation is reduced might even warrant the use of a shorter instrument, which would be easier to conceal and operate.

For heavy guns equipped with plotting boards for horizontal bases, the direction of the target may be plotted by a direction line drawn along the primary arm, and the measured ranges by a point on the direction line. A mean track can then be indicated by a line and predictions made along the line, the corrected ranges being the intersection of the line with the direction lines. The predicters would be held at the intersection of these lines.

In case it is found practicable to use the internal-base range-finder as an emergency instrument for mortars, the plotting of range-azimuth relations is considered advisable, in order that confusion may not arise in sending mixed data arising from the use of separate predicting instruments. Here, especially, is it necessary to reduce to a minimum the error of observation by plotting the mean track. To do this, it may be found necessary to plot time-range relation on a special board, to smooth the curve, and to use corrected ranges on the plotting board. To avoid delays, the corrected range may be predicted for a few seconds ahead. Further correction of the range-azimuth curve will not be required, and predictions will be based on the last two observation points, as in the case of horizontal-base tracking. This method permits the maximum frequency of observations and may be found advisable for use also with heavy guns under Case II.

In conclusion, the accuracy of internal-base range-finding may be very much increased by eliminating the error of adjustment and by reducing the effect of the error of observation by plotting a mean curve based upon as frequent observations as s practicable to obtain. For good work it is believed that error of the mean curve should not exceed that indicated Curve 1 of Plate I.

TABLE I

(From Fort Monroe Test)

Range by Horizontal Base, yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
5710	.0001751	5750	.0001739	−.0000012	+.00000068
5545	1803	5580	1792	−11	+ 78
5390	1855	5440	1838	−17	+ 18
5235	1910	5350	1869	−41	−222
5090	1965	5210	1919	−46	−272
4920	2033	5080	1969	−64	−452
4760	2110	4890	2045	−56	−372
4600	2174	4670	2141	−33	−142
4450	2247	4450	2247	0	+188
4300	2326	4290	2331	+ 5	+238
4140	2415	4160	2404	−11	+ 78
3990	2506	4020	2488	−18	+ 8
3840	2604	3880	2577	−27	− 82
3680	2717	3700	2703	−14	+ 48
3540	2825	3560	2809	−16	+ 28
3400	2941	3440	2907	−34	−152
3270	3058	3310	3021	−37	−182
3140	3185	3170	3155	−30	−112
3000	3333	3030	3300	−33	−142
2880	3472	2900	3448	−24	− 52
2750	3636	2780	3597	−39	−202
2630	3802	2610	3831	+29	+478
2500	4000	2490	4016	+16	+348
2380	4202	2360	4237	+35	+538
2260	4425	2240	4464	+39	+578
2140	4673	2160	4630	−43	−242
2030	4926	2040	4902	−24	− 52
			Mean	−18.8	±19.9

TABLE II

(From Fort Monroe Test)

6890	.0001451	6900	.0001449	−.0000002	−.00000205
6820	1466	6700	1493	+27	+ 85
6750	1481	6610	1513	+32	+135
6680	1497	6580	1520	+23	+ 45
6600	1515	6450	1550	+35	+165
6520	1534	6385	1566	+32	+135
6440	1553	6290	1590	+37	+185
6370	1570	6200	1613	+43	+245
6280	1592	6110	1637	+45	+265
6200	1613	6020	1661	+48	+295
6130	1631	5930	1686	+55	+365
6050	1653	5850	1709	+56	+375
5960	1678	5790	1727	+49	+305
5890	1698	5700	1754	+56	+375
5800	1724	5640	1773	+49	+305
5720	1748	5570	1795	+47	+285
5640	1773	5500	1818	+45	+265
5550	1802	5430	1842	+40	+215
5460	1832	5380	1858	+26	+ 75
5380	1859	5300	1887	+28	+ 95
5300	1887	5240	1908	+21	+ 25
5230	1912	5190	1927	+15	− 35
5150	1942	5105	1959	+17	− 15

TABLE II—Continued

(From Fort Monroe Test)

Range by Horizontal Base, yards	Recip-rocal	Range by Barr & Stroud yards	Recip-rocal	Error	Variation from Mean Error
5060	.0001976	5065	.0001974	– .0000002	–.0000205
4980	2008	5005	1998	–10	–285
4900	2041	4900	2041	0	–185
4815	2077	4815	2077	0	–185
4730	2114	4750	2105	– 9	–275
4650	2151	4615	2167	+16	– 25
4570	2188	4545	2200	+12	– 65
4480	2232	4465	2240	+ 8	–105
4400	2273	4340	2304	+31	+125
4320	2315	4250	2353	+38	+195
4240	2358	4205	2378	+20	+ 15
4150	2410	4140	2415	+ 5	–135
4070	2457	4040	2475	+18	– 5
3980	2513	3972	2518	+ 5	–135
3900	2564	3880	2577	+13	– 55
3810	2625	3855	2594	–31	–495
3730	2681	3761	2659	–22	–405
3650	2740	3650	2740	0	–185
3560	2809	3545	2821	+12	– 65
3480	2874	3498	2859	–15	–335
3400	2941	3395	2945	+ 4	–145
3320	3012	3300	3030	+18	– 5
3240	3086	3212	3113	+27	+ 85
3150	3175	3150	3175	0	–185
3080	3247	3089	3237	–10	–285
3000	3333	3000	3333	0	–185
2920	3425	2942	3399	–26	–445
			Mean	+18.5	+18.6

TABLE III

(From Fort Monroe Test)

6530	.0001531	6300	.0001587	+.0000056	+.00000974
6440	1553	6200	1613	+ 60	+1014
6340	1577	6090	1642	+ 65	+1064
6240	1603	6080	1645	+ 42	+ 834
6130	1631	6040	1656	+ 25	+ 664
6030	1658	5980	1672	+ 14	+ 554
5920	1689	5945	1682	– 7	+ 344
5810	1721	5880	1701	– 20	+ 214
5700	1754	5790	1727	– 27	+ 144
5580	1792	5690	1757	– 35	+ 64
5500	1818	5590	1789	– 29	+ 124
5380	1859	5490	1821	– 38	+ 34
5270	1897	5350	1869	– 28	+ 134
5760	1938	5275	1896	– 44	– 26
5070	1972	5220	1916	– 56	– 146
4960	2016	5100	1961	– 55	– 136
4860	2058	5020	1992	– 66	– 246
4750	2105	4945	2022	– 83	– 416
4650	2151	4845	2064	– 87	– 456
4530	2208	4690	2132	– 76	– 346
4410	2268	4520	2212	– 56	– 146
4310	2320	4400	2273	– 47	– 56
4200	2381	4240	2358	– 23	+ 184

TABLE III—Continued

(From Fort Monroe Test)

Range by Horizontal Base, yards	Recip-rocal	Range by Barr & Stroud yards	Recip-rocal	Error	Variation from Mean Error
4080	.0002451	4140	.0002415	− .0000036	+ .00000054
3970	2519	4020	2488	− 31	+ 104
3860	2591	3920	2551	− 40	+ 14
3750	2667	3800	2632	− 35	+ 64
3640	2747	3690	2710	− 37	+ 44
3530	2833	3575	2797	− 36	+ 54
3430	2915	3480	2874	− 41	+ 4
3320	3012	3370	2967	− 45	− 36
3210	3115	3250	3077	− 38	+ 34
3090	3236	3100	3226	− 10	+ 314
2990	3344	2970	3367	+ 23	+ 644
2890	3460	2850	3509	+ 49	+ 904
2780	3597	2770	3610	+ 13	+ 544
2670	3745	2740	3650	− 95	− 536
2570	3891	2575	3883	− 8	+ 334
2460	4065	2465	4057	− 8	+ 334
2360	4237	2370	4219	− 18	+ 234
2250	4444	2260	4425	− 19	+ 224
2140	4673	2155	4640	− 33	+ 84
2030	4926	2065	4843	− 83	− 416
1930	5181	1970	5076	−105	− 636
1820	5495	1855	5391	−104	− 626
1720	5814	1760	5682	−132	− 906
1610	6211	1620	6173	− 38	+ 34
1500	6667	1540	6494	−173	−1316
1400	7143	1450	6897	−246	−2046
1300	7692	1340	7463	−229	−1876
			Mean	−41.4	41.47

TABLE IV

(From Fort Monroe Test)

5680	.0001761	5650	.0001770	+.0000009	+.00000015
5780	1730	5900	1695	−35	−29
5880	1701	5925	1688	−13	− 7
5960	1678				
6050	1653	6075	1646	− 7	− 1
6170	1621				
6260	1597	6250	1600	+ 3	+ 9
6365	1571	6350	1575	+ 4	+10
6450	1550	6375	1568	+18	+24
6510	1536	6350	1575	+39	+45
6560	1524	6400	1563	+39	+45
6515	1535	6500	1538	+ 3	+ 9
6420	1558	6425	1556	− 2	+ 4
6320	1582	6275	1593	+11	+17
6210	1610	6275	1593	−17	−11
6110	1637	6075	1646	+ 9	+15
6010	1664	5975	1674	+10	+16
5895	1696	5890	1698	+ 2	+ 8
5800	1724	5825	1717	− 7	− 1
5680	1761	5750	1739	−24	−18
5560	1799	5555	1800	+ 1	+ 7
5475	1826	5475	1826	0	+ 6
5360	1866	5350	1869	+ 3	+ 9

TABLE IV—Continued

(From Fort Monroe Test)

Range by Horizontal Base, yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
5270	.0001897	5275	.0001896	−.0000001	+.00000005
5155	1940	5250	1905	−35	−29
5050	1980	5140	1946	−34	−28
4960	2016	5060	1976	−40	−34
4855	2060	4950	2020	−40	−34
4745	2107	4850	2062	−45	−39
4640	2155	4790	2088	−67	−61
4535	2205	4560	2193	−12	− 6
4430	2257				
4325	2312	4300	2326	+14	+20
4220	2370				
4105	2436	4175	2395	−41	−35
4000	2500	4000	2500	0	+ 6
3890	2571	3900	2564	− 7	− 1
3785	2642	3830	2611	−31	−25
3675	2721	3660	2732	+11	+17
3565	2805	3590	2786	−19	−12
3460	2890	3500	2857	−33	−27
3350	2985	3320	3012	+27	+33
3245	3081	3220	3106	+25	+31
3130	3195	3120	3205	+10	+16
3020	3311	3030	3300	−11	− 5
2915	3430	2920	3425	− 5	+ 1
2805	3565	2800	3571	+ 6	+12
2700	3704	2690	3717	+13	+19
			Mean	− 6.1	18.2

TABLE V

(From Fort Monroe Test)

2145	.0004662	2120	+.0004717	+.0000055	+.00000192
2235	4474	2190	4566	+ 92	562
2360	4237	2290	4367	+130	942
2420	4132	2360	4237	+105	692
2520	3968	2480	4032	+ 64	282
2620	3817	2570	3891	+ 74	382
2720	3676	2720	3676	0	−358
2820	3546	2790	3584	+ 38	+ 22
2930	3413	2950	3390	− 23	−588
3040	3289	3030	3300	+ 11	−248
3140	3185	3150	3175	− 10	−458
3250	3077	3220	3106	+ 29	− 68
3360	2976	3340	2994	+ 18	−178
3460	2890	3400	2941	+ 51	+152
3570	2801	3520	2841	+ 40	+ 42
3680	2717	3710	2695	− 22	−578
3800	2632	3770	2653	+ 21	−148
3910	2558	3850	2597	+ 39	+ 32
4035	2478	3980	2513	+ 35	− 8
160	2404	4090	2445	+ 41	+ 52
260	2347	4160	2404	+ 57	+212
390	2278	4270	2342	+ 64	+282
500	2222	4400	2273	+ 51	+152
25	2162	4460	2242	+ 80	+442

TABLE V—Continued

(From Fort Monroe Test)

Range by Horizontal Base, yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
4730	.0002114	4650	.0002151	+.0000037	+.00000012
4855	2060	4770	2096	+ 36	+ 2
4965	2014	4890	2045	+ 31	− 48
5070	1972	5050	1980	+ 8	−278
5200	1923	5140	1946	+ 23	−128
5310	1883	5210	1919	+ 36	+ 2
5430	1842	5340	1873	+ 31	− 48
5550	1802	5450	1835	+ 33	− 28
5660	1767	5560	1799	+ 32	− 38
5760	1736	5660	1767	+ 31	− 48
5880	1701	5750	1739	+ 38	+ 22
5990	1669	5910	1692	+ 23	−128
6100	1639	6050	1653	+ 14	−218
6230	1605	6200	1613	+ 8	−278
6340	1577	6350	1575	− 2	−378
6450	1550	6400	1563	+ 13	−228
				Mean +35.8	22.4

TABLE VI

(From Fort Monroe Test)

2740	.0003650	2720	.0003676	+.0000026	−.00000006
2815	3552	2800	3571	+19	− 76
2885	3466	2860	3497	+31	+ 44
2950	3390	2930	3413	+23	− 36
3020	3311	2980	3356	+35	+184
3080	3247	3050	3279	+32	+ 54
3145	3180	3110	3215	+35	+ 84
3215	3110	3180	3145	+35	+ 84
3285	3044	3260	3067	+23	− 36
3350	2985	3330	3003	+18	− 86
3415	2928	3420	2924	− 4	−306
3480	2874	3460	2890	+16	−106
3550	2817	3510	2849	+32	+ 54
3610	2770	3560	2809	+39	−124
3680	2717	3610	2770	+53	+264
3745	2670	3700	2703	+33	+ 64
3810	2625	3750	2667	+42	+154
3870	2584	3850	2597	+13	−136
3930	2545	3900	2564	+19	− 76
3999	2506	3960	2525	+19	− 76
4060	2463	4010	2494	+31	+ 44
4790	2088	4800	2083	− 5	−316
4850	2062				
4910	2037	4850	2062	+25	− 16
4980	2008	4950	2020	+12	−146
5030	1988	5000	2000	+12	−146
5095	1963	5050	1980	+17	− 96
5155	1940	5100	1961	+21	− 56
5700	1754	5550	1802	+48	+214
5750	1739	5620	1779	+40	+134
5800	1724	5740	1742	+18	− 86
5870	1704	5800	1724	+20	− 66
5940	1684	5850	1709	+25	− 16
5985	1671	5910	1692	+21	− 56

TABLE VI—Continued

(From Fort Monroe Test)

Range by Horizontal Base, yards	Recip-rocal	Range by Barr & Stroud yards	Recip-rocal	Error	Variation from Mean Error
6040	.0001656	5970	.0001675	+.0000019	-.00000076
6100	1639	6050	1653	+14	-126
6160	1623	6120	1634	+11	-156
6210	1610	6180	1618	+ 8	-186
6580	1520	6420	1558	+38	+114
6640	1506	6480	1543	+37	+104
6690	1495	6530	1531	+36	+ 94
6750	1481	6590	1517	+36	+ 94
6800	1471	6630	1508	+37	+104
6855	1459	6690	1495	+38	+ 94
6910	1447	6750	1481	+34	+ 74
6970	1435	6800	1471	+36	+ 94
7025	1424	6850	1460	+36	+ 94
7085	1411	6900	1449	+38	+114
				Mean +26.6	10.57

TABLE VII

(From Fort Wool Test: Battery Hindman)

1560	.0006410	1550	.0006451	+.0000041	+.0000070
1690	5917	1680	5952	+ 35	+64
1835	5450	1860	5376	- 74	-45
1975	5063	2000	5000	- 63	-34
2125	4706	2160	4630	- 76	-47
2280	4386	2345	4264	-122	-93
2435	4107	2430	4115	+ 7	+37
2585	3868	2575	3883	+ 15	+44
2750	3636	2810	3559	- 77	-48
2910	3436	2940	3401	- 35	- 6
3070	3257	3075	3252	- 5	+24
3235	3091	3225	3101	+ 10	+39
3405	2937	3450	2899	- 38	- 9
3575	2797	3600	2778	- 19	+10
3745	2670	3790	2639	- 31	- 2
				Mean - 29	38

TABLE VIII

(From Fort Wool Test: Battery Hindman)

2245	.0004454	2285	.0004376	-.0000078	-.0000084
2395	4175	2425	4124	-51	-57
2550	3922	2545	3929	+ 7	+ 1
2700	3704	2645	3781	+77	+71
2850	3509	2775	3604	+95	+68
3005	3328	2990	3344	+16	+10
3160	3165	3160	3165	0	- 6
3315	3017	3345	2990	-27	-33
3470	2882	3450	2899	+17	+11
3625	2759	3645	2743	-16	-22
3775	2649	3800	2632	-17	-23
3930	2545	3850	2597	+52	+46
				Mean + 6	±38

TABLE IX

(From Fort Wool Test: Battery Hindman)

Range by Horizontal Base, yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
1780	.0005618	1760	.0005682	+.0000064	+.0000051
1680	5952	1675	5970	+ 28	+ 15
1585	6309	1560	6410	+101	+ 88
1500	6667	1480	6757	+ 90	+ 77
1415	7067	1410	7092	+ 25	+ 12
1350	7407	1340	7463	+ 56	+ 43
1300	7692	1330	7519	−173	−186
1262	7924	1280	7813	−111	−124
1245	8032	1250	8000	− 32	− 45
1240	8065	1230	8130	+ 65	+ 52
1245	8032	1240	8065	+ 33	+ 20
			Mean	+ 13	65

TABLE X

(From Fort Worden Test: Battery Kinzie)

1590	.0006289	1690	.0005917	−.0000372	−.0000257
1690	5917	1770	5648	−271	−156
1780	5618	1860	5376	−242	−127
1860	5376	1950	5128	−248	−133
1960	5102	2040	4902	−200	− 85
2040	4902	2110	4739	−163	− 48
2130	4695	2230	4484	−211	− 96
2230	4484	2300	4348	−136	− 21
2320	4310	2390	4184	−126	− 11
2410	4149	2490	4016	−133	− 18
2500	4000	2590	3861	−139	− 24
2600	3846	2680	3731	−115	0
2700	3704	2780	3597	−107	+ 8
2790	3584	2880	3472	−112	+ 3
2880	3472	2970	3367	−105	− 10
2980	3356	3080	3247	−109	+ 6
3080	3247	3190	3135	−112	+ 3
3170	3155	3280	3049	−106	+ 9
3270	3058	3380	2959	− 99	+ 16
3370	2967	3490	2865	−102	+ 13
3470	2882	3580	2793	− 91	+ 24
3570	2801	3680	2717	− 84	+ 31
3670	2725	3790	2639	− 86	+ 29
3770	2653	3880	2577	− 76	+ 39
3860	2591	3980	2513	− 78	− 37
3960	2525	4100	2439	− 86	+ 29
4060	2463	4200	2381	− 82	+ 33
4150	2410	4300	2326	− 84	+ 31
4250	2353	4400	2273	− 80	+ 35
4340	2304	4500	2222	− 82	+ 33
4440	2252	4600	2174	− 78	+ 38
4530	2208	4700	2128	− 80	+ 35
4630	2160	4800	2083	− 77	+ 38
4720	2119	4900	2041	− 78	+ 37
4810	2079	5000	2000	− 79	+ 36
4900	2041	5100	1961	− 80	+ 35
5000	2000	5200	1923	− 77	+ 38
5090	1965	5300	1887	− 78	+ 37
5190	1927	5400	1852	− 75	+ 40
5290	1890	5500	1818	− 72	+ 43

TABLE X—Continued

(From Fort Worden Test: Battery Kinzie)

Range by Horizontal Base, yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
5390	.0001855	5600	.0001786	−.0000069	+.0000046
5490	1821	5700	1754	− 67	+ 48
5580	1792	5800	1724	− 68	+ 47
5690	1757	5900	1695	− 62	+ 53
				Mean −115	44

TABLE XI

(From Fort Caswell Test: Battery Swift)

3520	.0002841	3480	.0002874	+.0000033	−.00000662
3590	2786	3590	2786	0	−992
3710	2695	3690	2710	15	−842
3830	2611	3800	2632	21	−782
3960	2525	3890	2571	46	−532
4450	2247	4380	2283	36	−632
4690	2132	4430	2257	25	−742
4970	2012	4270	2342		
4620	2165	4460	2242	77	−222
4760	2101	4560	2193	92	− 72
4910	2037	4670	2141	104	+ 48
5070	1972	4760	2101	129	+298
5210	1919	4880	2049	130	+308
5360	1866	4990	2004	138	+388
5510	1815	5110	1957	142	+428
5680	1761	5350	1869	108	+ 88
6200	1613	5900	1695	82	−172
6450	1550	6010	1664	114	+148
6600	1515	6110	1637	122	+228
6750	1481	6220	1608	127	+278
6890	1451	6390	1565	114	+148
7060	1416	6490	1541	125	+258
7210	1387	6620	1511	124	+248
7490	1335	7030	1422	87	−122
7640	1309	7300	1370	61	−382
7780	1285	7400	1351	66	−332
7890	1267	7540	1326	59	−402
8090	1236	7690	1300	64	−352
8230	1215	7800	1282	67	−322
8360	1196	7990	1252	56	−432
8510	1175	8100	1235	60	−392
8650	1156	8280	1208	52	−472
8730	1145	8430	1186	41	−582
8960	1116	8550	1170	54	−452
9100	1099	8660	1155	56	−432
9220	1085	8750	1143	58	−412
9350	1070	8900	1124	54	−452
9510	1052	9090	1100	48	−512
10600	943	9990	1001	58	−412
11550	866	10400	996	130	+308
11900	840	10600	943	103	+ 38
12050	830	10720	933	103	+ 38
12190	820	10900	917	97	− 22
11950	837	10090	991	154	+548
11670	857	10000	1000	143	+438
11550	866	9910	1009	143	+438

TABLE XI—Continued

(From Fort Caswell Test: Battery Swift)

Range by Horizontal Base, yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
11370	.0000880	9880	.0001012	+.0000132	.00000+328
11270	887	9780	1022	135	+358
11100	901	9670	1034	133	+338
10960	912	9550	1047	135	+358
10820	924	9450	1058	134	+348
10690	935	9370	1067	132	+326
10540	949	9190	1088	139	+396
10390	962	9080	1101	139	+398
10270	974	8980	1114	140	+408
9150	1093	8370	1195		+ 28
8990	1112	8190	1221	109	+ 98
8850	1130	7990	1252	122	+228
8710	1148	7830	1277	129	+298
8570	1167	7730	1294	127	+278
8440	1185	7620	1312	127	+278
8290	1206	7470	1339	133	+338
8150	1227	7250	1379	150	+508
7870	1271	7300	1370	99	− 2
7730	1294	7200	1389	95	− 42
7610	1314	7130	1403	89	−102
7440	1344	6890	1451	107	+ 78
7290	1372	6710	1490	118	+188
7160	1397	6640	1506	109	+ 98
7010	1427	6530	1531	104	+ 48
6880	1453	6410	1560	107	+ 78
6750	1481	6310	1585	104	+ 48
6600	1515	6170	1621	106	+ 68
6450	1550	5990	1669	119	+198
6320	1582	5840	1712	130	+308
6180	1618	5740	1742	124	+248
6040	1656	5550	1802	146	+468
5900	1695	5440	1838	143	+438
5750	1739	5330	1876	137	+378
5630	1776	5210	1919	143	+438
5480	1825	5140	1945	120	+208
5340	1873	5020	1992	119	+198
5200	1923	4940	2024	101	+ 18
5060	1976	4820	2075	99	− 2
4930	2028	4740	2110	82	−172
4790	2088	4600	2174	86	−132
4660	2146	4520	2212	66	−332
4520	2212	4480	2232	20	−792
4390	2278	4200	2381	103	+ 38
4230	2364	4070	2457	93	− 62
4120	2427	3960	2525	98	− 12
3990	2506	3800	2632	126	+268
			Mean	+99.2	30.3

TABLE XII

(From Fort Monroe Test: Fixed target)

Actual Range yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
1565	.0006390	1560	.0006410	+.0000020	+.00000166
		1545	6472	+82	+786
		1560	6410	+20	+166
		1570	6369	−21	−244
		1565	6390	0	− 34
3902	2563	3950	2532	−31	−344
		3915	2554	− 9	−124
		3910	2558	− 5	− 84
		3920	2551	−12	−154
		3950	2532	−31	−544
1565	6390	1563	6398	+ 8	+ 46
		1560	6410	+20	+166
		1555	6431	+41	+376
		1550	6452	+62	+586
		1555	6431	+41	+376
6502	1538	6400	1562	+24	+206
		6900	1449	−89	−924
		6800	1471	−67	−704
		6500	1538	0	− 34
		6400	1562	+24	+206
6100	1639	6100	1639	0	− 34
		6090	1642	+ 3	− 4
		6120	1634	− 5	− 84
		6170	1621	−10	−214
		6050	1653	+24	+206
9230	1083	9340	1071	− 8	−114
		9100	1099	+16	+126
		9100	1099	+16	+126
		9180	1089	+ 6	+ 26
		9300	1075	− 8	−114
			Mean	+3.4	23.7

TABLE XIII.

(From Fort Monroe Test: Fixed target)

6502	.0001538	6500	.0001538	.0000000	−.00000031
		6470	1546	+ 8	+ 49
		6450	1550	+12	+ 89
		6400	1562	+24	+209
		6450	1550	+12	+ 89
		6500	1538	0	− 31
		6500	1538	0	− 31
		6425	1556	+18	+149
		6450	1550	+12	+ 89
		6425	1556	+18	+149
3902	2563	3890	2570	+ 7	+ 39
		3910	2558	− 5	− 81
		3940	2538	−25	−281
		3900	2564	+ 1	− 21
		3920	2551	−12	−151
		3890	2571	+ 8	+ 49
		3900	2564	+ 1	− 21
		3910	2558	− 5	− 81
		3920	2551	−12	−151
		3900	2564	+ 1	− 21
			Mean	+ 3.1	9.1

TABLE XIV

(From Fort Monroe Test: Fixed target)

Actual Range yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
6502	.0001538	6620	.0001511	−.0000029	−00000048
		6660	1502	−36	−118
		6600	1515	−23	+ 12
		6580	1520	−18	+ 62
		6580	1520	−18	+ 62
1565	6390	1565	6390	0	+242
		1575	6349	−41	−168
		1568	6378	−12	+122
		1564	6394	+ 4	+282
		1565	6390	0	+242
3902	2563	3950	2532	−31	− 68
		3955	2528	−35	−108
		3975	2516	−47	−228
		3940	2538	−25	− 8
		3930	2545	−18	+ 62
6100	1639	6250	1600	−39	−148
		6220	1608	−31	− 68
		6220	1608	−31	− 68
		6180	1618	−21	+ 32
		6180	1618	−21	+ 32
9230	1083	9300	1075	− 8	+162
		9450	1058	−25	− 8
		9400	1064	−19	+ 52
		9600	1042	−41	−168
		9600	1042	−41	−168
				Mean −24.2	10.95

TABLE XV

(From Fort Caswell Test: Battery Swift, night observations)

Range by Horizontal Base, yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
2890	.0003460	2900	.0003448	−.0000012	−.0000132
2910	3436	2940	3401	− 35	−155
3030	3300	2999	3344	+ 44	− 76
3200	3125	3080	3247	+122	+ 2
3430	2915	3310	3021	+106	− 14
3650	2740	3540	2825	+ 85	− 35
3910	2558	3730	2681	+123	+ 3
4160	2404	3950	2532	+128	+ 8
4400	2273	4200	2381	+108	− 12
4620	2165	4350	2299	+134	+ 14
5070	1972	4690	2132	+160	+ 40
7650	1307	5070	1972	+665*	+545*
8290	1206	7100	1408	+202	+ 82
8580	1166	7200	1389	+223	+103
9020	1109	7530	1328	+219	+ 99
9640	1037	8100	1235	+198	+ 78
		Mean, excluding 1 reading		+120	57

* Thrown out.

TABLE XV—Continued

(From Fort Caswell Test: Battery Swift, night observations)

Range by Horizontal Base, yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
6420	.0001558	6100	.0001639	+.0000081	+.0000047
5970	1675	5950	1681	+ 6	− 26
5630	1776	5790	1727	− 49	− 83
5270	1898	5600	1786	−112	−146
4660	2146	4700	2128	− 18	− 52
4490	2227	4300	2326	+ 99	+ 65
4450	2247	4100	2439	+192	+158
4100	2439	3960	2525	+ 86	+ 52
3860	2591	3740	2674	+ 83	+ 49
3500	2857	3500	2857	0	− 34
3280	3049	3400	2941	−108	−142
3080	3247	2950	3390	+143	+109
				Mean + 34	80

TABLE XVI

(From Fort Monroe Test: Night practice)

1505	.0006645	1477	.0006770	+.0000125	+.0000105
1600	6250	1571	6365	+115	+ 95
1680	5952	1660	6024	+ 72	+ 52
1780	5618	1735	5764	+146	+126
1870	5348	1855	5391	+ 43	+ 23
1960	5102	1890	5291	+189	+169
2050	4878	2017	4958	+ 80	+ 60
2135	4684	2110	4739	+ 55	+ 35
2225	4494	2253	4439	− 45	− 65
2315	4320	2353	4250	− 70	− 90
2400	4167	2425	4124	− 43	− 63
2490	4016	2504	3994	− 22	− 42
2575	3883	2589	3862	− 21	− 41
2670	3745	2690	3717	− 28	− 48
2760	3623	2795	3578	− 45	− 65
2850	3509	2869	3486	− 23	− 43
2935	3407	2935	3407	0	− 20
3030	3300	3025	3306	+ 6	− 14
3115	3210	3134	3191	− 19	− 39
3205	3120	3230	3096	− 24	− 44
3300	3030	3323	3009	− 21	− 41
3390	2950	3395	2946	− 4	− 24
3485	2869	3474	2879	+ 10	− 10
3580	2793	3552	2815	+ 22	+ 2
3660	2732	3640	2747	+ 15	− 5
3755	2663	3730	2681	+ 18	− 2
3855	2594	3800	2632	+ 38	+ 18
3935	2541	3925	2548	+ 7	− 13
4035	2478	4025	2484	+ 6	− 14
				Mean + 20	47.3

TABLE XVII

(From Fort Monroe Test: Night practice)

Range by Horizontal Base, yards	Reciprocal	Range by Barr & Stroud yards	Reciprocal	Error	Variation from Mean Error
1515	.0006601	1540	.0006494	−.0000107	−.00000885
1610	6211	1640	6098	−113	− 945
1700	5882	1750	5714	−168	−1495
1795	5571	1850	5405	−166	−1475
1885	5305	1920	5208	− 97	− 785
1980	5051	2040	4902	−149	−1305
		2130			
		2240			
2360	4237	2330	4292	+ 55	+ 735
2465	4057	2440	4098	+ 41	+ 595
2550	3922	2550	3922	0	+ 185
2665	3752	2670	3745	− 7	+ 115
2765	3617	2800	3571	− 46	− 275
2870					
2980	3356	3000	3333	− 23	− 45
3080	3247	3110	3215	− 32	− 135
3615	2766	3680	2717	− 49	− 305
3510	2849	3500	2857	+ 8	+ 265
3410	2933	3400	2941	+ 8	+ 265
3305	3026	3320	3012	− 14	+ 45
3200	3125	3150	3175	+ 50	+ 685
3100	3226	3070	3257	+ 31	+ 495
3000	3333	2990	3344	+ 11	+ 295
2895	3454	2880	3472	+ 18	+ 365
2790	3584	2800	3571	− 13	+ 55
2685	3724	2700	3704	− 20	− 15
2580	3876	2580	3876	0	+ 185
2470	4049	2470	4049	0	+ 185
2370	4219	2350	4255	+ 36	+ 545
2270	4405	2240	4464	+ 55	+ 735
2165	4619	2140	4673	+ 54	+ 725
2065	4843	2030	4926	+ 83	+1015
1960	5102	1960	5102	0	+ 185
			Mean	− 18.5	51.1

(At the end of each table the mean errors are given as the reciprocal × 10^7.)

PROFESSIONAL NOTES

A NEW MOUNTING FOR BIG NAVAL GUNS

It is not to be expected that those who have had no opportunities of studying the mountings of big naval guns—and opportunities grow less in number every day as the secrecy of admiralties increases—should be, even broadly, acquanited with the marvelous mechanism which has been developed in the last thirty or forty years. Whilst, then, offering our apologies to those who are intimate with all the details of shell room, magazine, and gun-house, we venture to think we shall be doing a service to others if, before describing a new Elswick mounting which we have recently had the privilege of inspecting in detail, we describe broadly the general features which are to be found in most modern mountings for big naval guns. If we did not adopt this course much of what follows would, of necessity, be obscure to many of our readers.

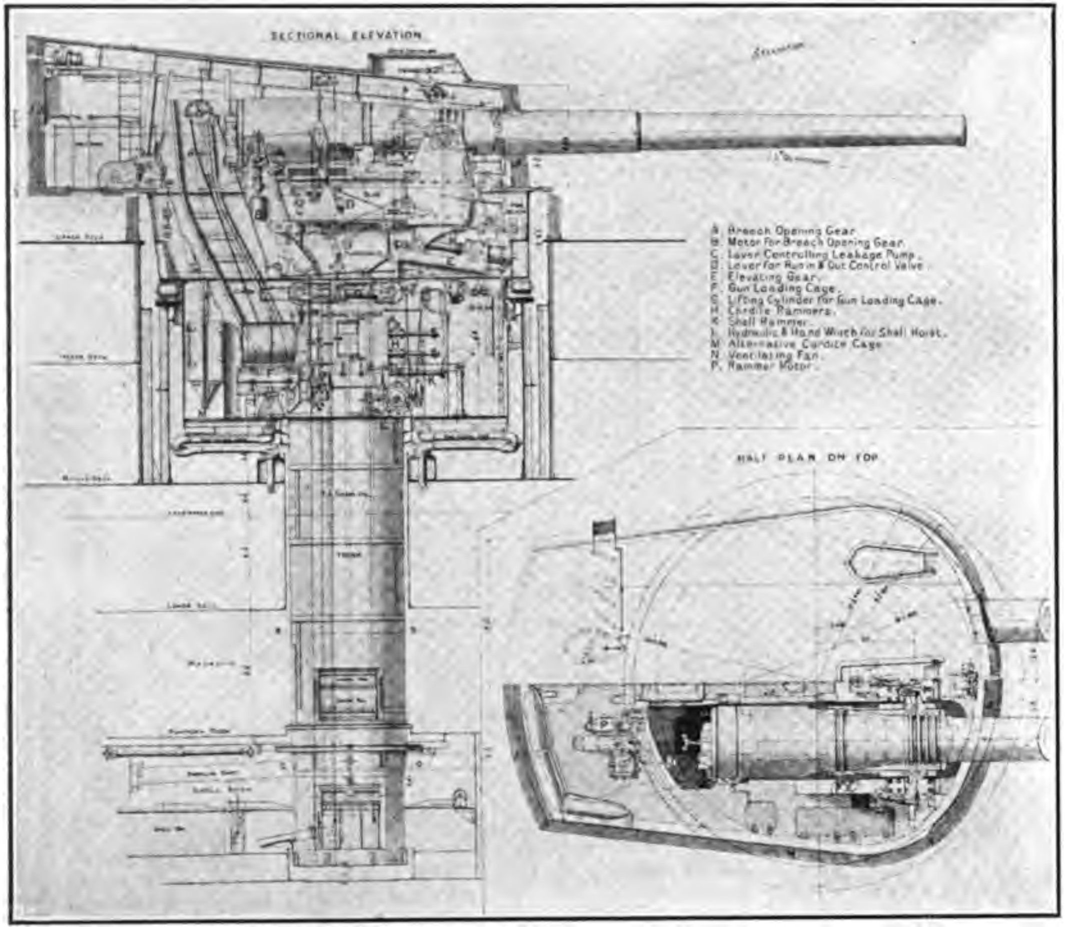
We shall write of a twin mounting, but for convenience shall consider but one-half of it; for it may, with the single exception of training—that is to say, the movement of the gun horizontally—be regarded as divided into two exactly similar parts by a vertical plane. On the deck of the ship is the gun-house, a structure built up of heavy armor plate, from which project rather more than half the length of the gun. The exposed portion of the gun-house has a round front, flat side, and a rounded back; it is closed on top by a sloping roof. This structure forms the shield proper; it is continued immediately below in a circular form, this part being of comparatively thin steel plate and protected from damage by a circular armored wall built rigidly into the structure of the ship—the barbette proper. Still further down is another circular room of rather smaller diameter, known as the working chamber. In its center is a large round opening, below which a huge steel tube, known as the trunk, descends almost to the bottom of the ship. The trunk, the working chamber, and the gun-house are all in one piece, carried on a live roller ring, and therefore capable of being rotated on their common vertical axis. In training the guns the whole of this structure moves.

Return now to the gun-house. Near the forward part is built up a massive steel structure with great bearings for the trunnions, which permit the gun to be elevated and depressed. The gun itself is mounted in a cradle, and the cradle rests on a box-like structure called the slide. On the forward part of the slide are formed the trunnions, which rest in the bearings already mentioned. When the gun is fired the cradle is driven back along the slide by the recoil and is gradually brought to rest by an hydraulic buffer. The cradle and gun are then pushed out again by hydraulic cylinders to the forward or firing position. Elevation is effected by an hydraulic cylinder below the slide. All these parts can be seen in the drawings, * * * [pages 80 and 81], with the exception of the recoil and running-out cylinders, which are concealed in the slide.

The general construction of the mounting will now be understood. It is only necessary to add that one man, placed centrally in the gun-house, trains both guns. He sits with his eye to a telescope sight and moves the guns to right or left by turning a wheel. He gives his whole attention to keeping his telescope upon the target and has nothing else whatever to think of. Beside him sits another man with a graduated dial in front of him. By turning the dial he moves the telescope slightly to right or left so as to allow for the speed of his own vessel, of an enemy's vessel, the force of the wind, and so on. He receives instructions on a dial operated from the control stations. All he has to do is to make the graduated dial in front of him agree with this control dial. He has nothing else to do or to think of. These two men, working together and yet quite independently, keep the two guns pointing always in the direction of the target. The man who fires the gun has nothing to do but to elevate the gun and pull a trigger at the right instant. There is one gun-layer to each gun. They stand on the outside of their guns and each of them looks through a telescope at the target. By moving a hand wheel, or, in the present case, by moving a lever, each man elevates or depresses his own gun, and as soon as his sight is on the target he pulls the trigger and fires. It will be seen from this brief description that the training and elevating are in the hands of two independent men, one thinking only of bringing his gun to the mark horizontally and the other of bringing it to its mark vertically. It will be noticed, however, that as the man elevating can see the target through his telescope he can wait the right moment of training to fire. It may, however, be taken as a general rule that, since training takes place during the time spent in loading the gun, the gun will always be trained to the right position before it is ready to be fired.

Let us now consider the question of loading. If reference is made to the drawings it will be seen that the trunk passes through the middle deck, the lower deck, and the platform deck Below the latter is the shell-room, and above it is the magazine. Doors are pierced through the trunk on two sides in both these rooms. Inside the trunk lifts travel, one for each gun. Each lift brings up a shot from the shell-room and cordite charges from the magazine. The cages are raised at great speed to the working chamber and there come to rest. Hydraulic rammers then push the shell and the charges into a second cage, which at once rises to the rear of the gun. The gun by this time has reached the loading angle, 5 deg. of elevation, its breech has been thrown open, the gases of the previous charge have been blown out through the muzzle by a strong blast of air, and a jet of water has been squirted into the chamber and on to the face or pad of the breech block to extinguish any burning particles that may be left. Everything then is ready for a new charge. The cage having come to rest a chain rammer forces the shot home. The rammer is then withdrawn and in quick succession drives the cordite charges in after the shot. The breech closes instantly, the gun is released from the lock which has held it at the fixed angle of elevation, and it is ready to be fired.

The rapidity with which this sequence of operations is gone through is marvelous. In less than twenty seconds the charge and shell are whipped up the trunk, pushed into the second cage, raised up to the breech of the gun, rammed home, the breech closed, and the gun ready to fire a second round. We had the pleasure of seeing this done with the Armstrong mounting we are about to describe. Furthermore, to show how beautiful the interlocking mechanism is and how perfect the single lever control, which is the principal


SECTIONAL ELEVATION
HALF PLAN ON TOP
A. Breech Opening Gear.
B. Motor for Breach Opening Gear.
C. Lever Controlling Leakage Pump.
D. Lever for Run in & Out Control Valve.
E. Elevating Gear.
F. Gun Loading Cage.
G. Lifting Cylinder for Gun Loading Cage.
H. Cordite Rammers.
K. Shell Rammer.
L. Hydraulic & Hand Winch for Shell Hoist.
M. Alternative Cordite Cage.
N. Ventilating Fan.
P. Rammer Motor.

The Engineer.

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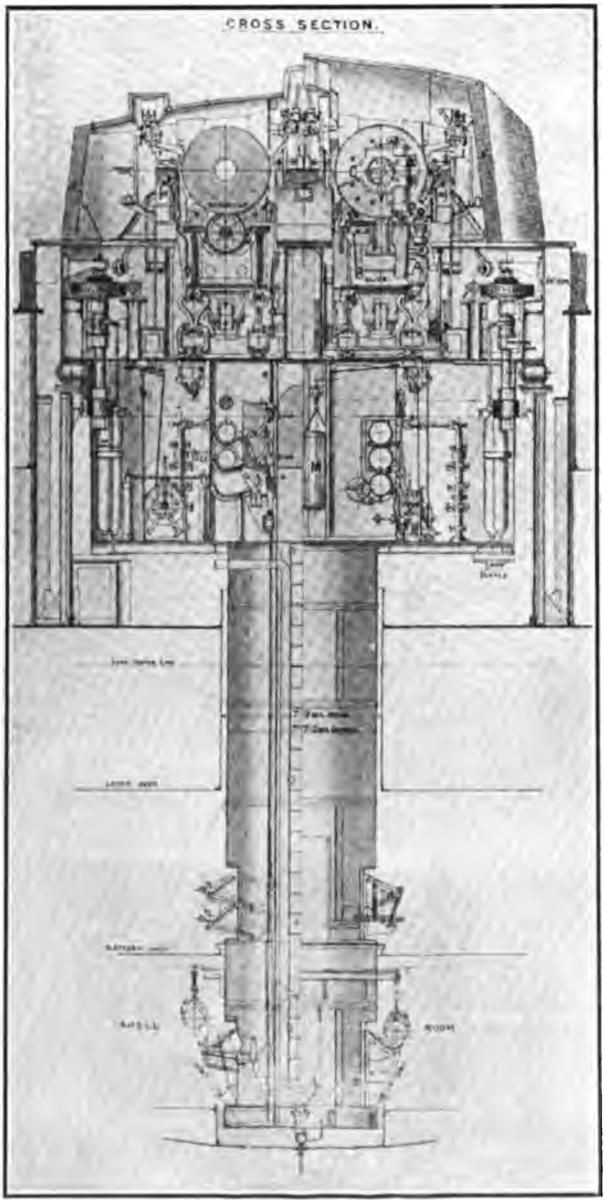
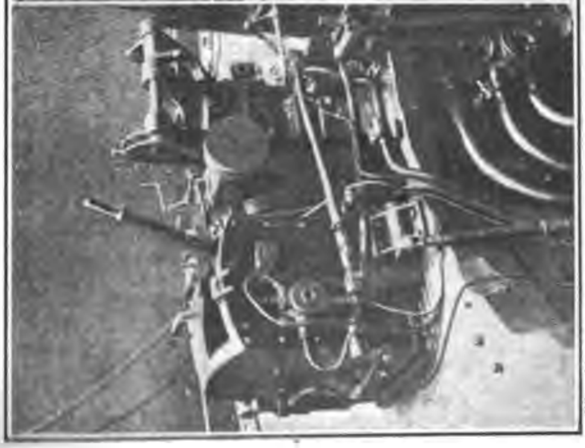


The Engineer. 1304



The Engineer

FIG. 1.

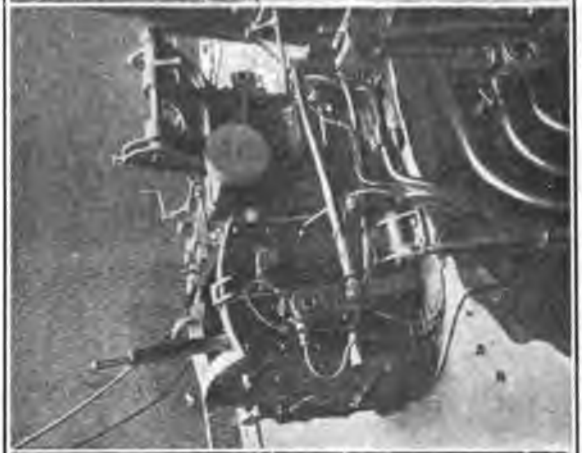
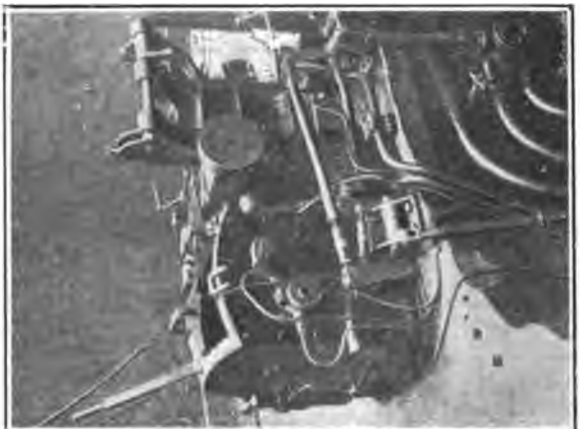


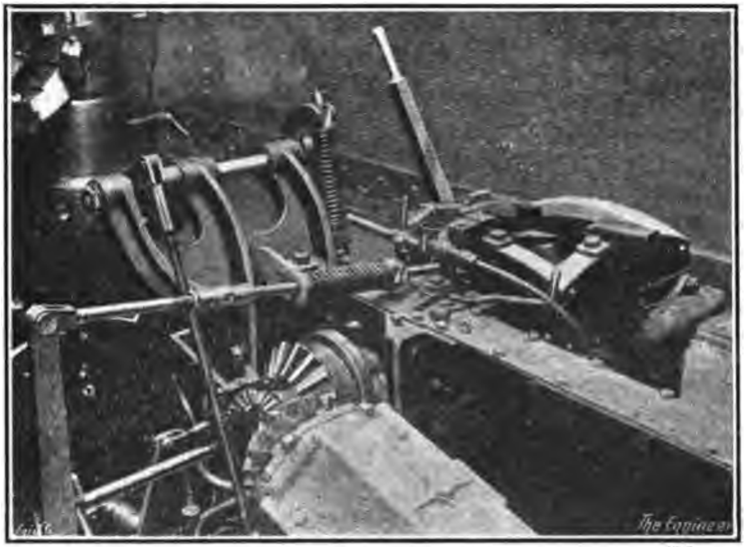
FIG. 2.



1305

FIG. 3.

feature of this mounting, we may say that we operated the mechanism ourselves, at the first time of handling, with perfect certainty that nothing could go amiss, in little, if any, more than a quarter of a minute. All that has to be done is on the word "ready" to move a lever round the four sides of a square. The motions are interlocked, so that they cannot take place in the wrong order, and another motion cannot begin till the effect caused by the preceding motion is complete. Thus it is impossible to make a mistake, and it is possible for a single untrained man to load the gun with absolute certainty. The only thing to say of the motion is that is is enchanting. The feeling of control of the enormous power that is called into play to deal with heavy loads at lightning speed, combined with the certainty that it will always take place with the regularity and precision of clockwork, is not only fascinating but compels our admiration of the engineers who have worked out the system. We should like to say more, but it is now time to turn to a more technical description.



The Engineer. 1306

Fig. 4.

The mounting we are dealing with has been made by Sir W. G. Armstrong, Whitworth and Co., Limited, for a battleship which is now under construction at the Elswick Shipyard for a foreign Power.

The system, which is equally applicable to turret guns of whatever weight, must not be described as new, for every element of which it is made up is well known and has been thoroughly tried. The grouping of these elements is, however, new, and presents, we think it will be admitted, a marked improvement on any gun mounting previously designed. The improvements lie mainly in the direction of rapid working, as indicated in our opening remarks; but combined with this is economy of men and simplicity of operation. With previous 12 in. or 13.5 in. mountings it requires a very well drilled crew to load a gun in 30 seconds. This speed of working can hardly ever be maintained. But with the present mounting there is, as we have already said, no difficulty in loading in 20 seconds. Indeed, we are informed that during a trial of endurance the loading operations were gone through two hundred times with a resultant average of 19 seconds.

The main feature of the mounting is that one lever works all the machinery in the gun-house and thus replaces four levers. The one lever performs the various operations in rotation by working round the four sides of a square, the motion along each side performing a distinct and separate operation. First, opening the breech; secondly, placing the gun in the loading position; thirdly, raising the gun loading cage; fourthly, working the rammer. Then, by reverse motions, withdrawing the rammer, lowering the cage, etc. In previous existing mountings these operations are all performed with different levers, and another lever to bring the cordite charge in position for ramming is also fitted. From the explanation which follows it will be seen that the last-named lever is not required in the new mounting.

Now, although all the four motions mentioned above are worked by one lever, it must be clearly understood that the machinery corresponding to each motion is always under control, and can, if necessary, be stopped or reversed at any moment. But, although a separate motion of the lever is required for each operation of the machinery, the valves working the machinery are so designed that no motion of the machinery which is dependent on a preceding motion can take place until that motion is complete. The result of this interlocking is that it is impossible to work the single lever too quickly or for an accident to happen, and yet there is not a single valve in the new mechanism which is not to be found in previous well-tried gun mountings. This master lever is shown in its four positions in the illustrations [Figs. 1, 2, 3 and 4]. We call it the master lever because, as a matter of fact, it engages with any one of four other levers, and it is the latter which open the valves, but it is known to the makers as the "churn" lever. Drawings cannot be given, but it will not be difficult to make the action, which is extremely simple, clear by words only, with the help of the photographic reproductions heregiven. Looking at view Fig. 1, for example, it will be seen that the master lever stands inside a square box. The lever is pivoted at the center of the bottom of this box in a kind of universal joint. On each side of the box, inside, there is another lever, four in all, each controlling a separate valve. These levers are pivoted near the bottom. In their upper ends are oblong holes. One of these lever heads can just be seen in Fig. 4. On the master lever is fashioned a strong cross, each projection of which can engage with the hole in one of the lever heads. For example, in Fig. 1, the cross on the master lever is engaged with the head of a lever on the side of the box nearest the spectator. Thus when the master lever is moved from right to left it pulls this lever over with it and opens a certain valve. Reaching the left-hand position, another arm of the cross engages with a lever standing up on the left side of the box. When, then, the master lever is pulled backward along the second side of the box it leaves the first valve lever in its left-hand position and draws the second valve lever backwards; at the third and fourth corners the cross on the master lever engages with third and fourth valve levers in the same way.

It will be observed that by this beautifully simple arrangement each valve lever is left in position for the return motion of the master lever, which moves them one by one to their original position as it is pulled backwards, pushed to the left, pushed forward, and pushed to the right in turn. One other point need only be mentioned. The inside top edges of the "box" are turned down and engage with upturned lips on the master lever. Thus once the latter has moved from a corner it is held in engagement with the proper valve lever and cannot leave it till another corner, where the downward lip of the box is cut away, is reached. By this very simple, but very ingenious, arrangement it is impossible to move the master lever in any way except round the four sides of the square, and hence it is impossible to open any valve out of its proper order. It is clear also that it is impossible to do anything that would disturb the right sequence of events

Now, although one lever controls the different operations in sequence, arrangements are made so that any operation may be performed separately and without reference to any other. This provision is made specially for cases of examination or repair. It would never be required for ordinary working of the gun mounting as a whole. It is effected by moving any one of the valve levers by hand.

The gain in rapidity of working is due mostly to an improvement in the gun loading hoist, but much saving of time can be attributed to the fact that there is a single operator at the "churn" lever who need never be delayed by having to think of what he has next to do, or wait for some one else to complete another operation. Any man at all versed in working heavy guns can without training to this special mounting, work its single lever and load the gun as rapidly as another man who may have worked it for a long period. We may avoid saying that machinery takes the place of brains, but it will certainly render the working of those brains much more easy at times of difficulty, such as the stress of battle.

The mounting we are about to describe is designed for loading at a fixed angle of elevation. The advantages and disadvantages of this condition are matters of controversy which we have not the space to do justice to here. Suffice it to say that the fixed angle of elevation mounting saves space—about 2 ft. in the length of the ship per mounting—and that space is an all-important matter in the ship for which this mounting is destined. But the principal features are just as suitable for any angle loading as for fixed angle; and, indeed, nearly all the details are being fitted to a mounting designed for the former, but the design is perhaps more simple and attractive with fixed angle loading than it is with any angle loading. Another important advantage of fixed loading must be mentioned. It is now an invariable practice to use water after each round, in addition to the air blast for expelling gases, and if the refinements of correction to sights on account of temperature and atmospheric conditions be considered, it seems strange that greater variations in range due to the possibility of a considerable amount of water remaining in the chamber should in a mounting which can be loaded at any angle of elevation be neglected. The fixed angle of loading selected is 5 deg. elevation, so that all water may run out of the chamber.

The "churn" lever is placed on the platform in rear of the gun, whence the operator can see the result of every motion he controls. He stands behind it facing the breech of the gun—that is to say, he would be facing the spectator in Fig. 1.

The following are the motions required:—(1) Open the breech; (2) place gun at loading angle; (3) raise the gun loading cage; (4) ram shot; (5) withdraw rammer; (6) ram first half charge; (7) withdraw rammer; (8) ram second half charge; (9) withdraw rammer; (10) lower cage (to clear); (11) free the gun from loading angle; (12) close the breech.

Motion No. 1 (*see Fig. 1*).—The lever is pulled from right to left or left to right in the same direction as the breech block swings. Starting from the position Fig. 1, the operator would move the churn lever to his right, opening the breech.

The breech mechanism is what is known as short-armed; that is to say, the block is first unscrewed, then drawn to the rear, then swung. The long-armed mechanism, truly, does away with the motion of withdrawal, but it necessitates a sharply coned pad, a hinge or pivot a long distance off the breech opening, and a long radial arm to connect the breech block with the hinge. All these features carry objections which are more and more accentuated as the size of the gun increases. We may mention that in a 15 in. gun the block and its appurtenances weigh over one ton, and have to be carried on an arm nearly 3 ft. long, whilst for the same gun with short-armed mechanism the swinging radius is only 14 in. These objections to the long-armed mechanism, in the opinion of the designers of the gun mounting under description, far outweigh any possible disadvantage involved by the drawing back of the screw in the short-arm mechanism. In this connection it is interesting to note that the three-motion short-armed mechanism has recently gone through the severe ordeal of being opened and closed at extra speed—1300 times in rapid succession—without any injury whatever. The three motions of opening the breech are, of course, combined, and are all worked from a single shaft operated by a hydraulic cylinder or swash plate engine.

Motion No. 2 (Fig. 2).—Placing the gun at the loading angle is reserved for the second motion, first, because it takes less time than opening the breech, and, secondly, because it is often convenient, and never objectionable, to open or close the breech without necessarily having to bring the gun to its loading angle.

The mechanism for Motion No. 2 is so arranged that the controlling lever has always to be pulled rearwards, whether the gun is above the loading angle or below it. Hence the operator has nothing to do but to pull the lever over to its full travel. The breech of the gun will then be raised or lowered automatically, as necessary, and will finally come gently to rest. The moment the lever is worked for this operation the pressure is shut off from the ordinary elevating valve used by the gun-layer, so that he can no longer control the elevation. After loading, the lever, as it goes backwards round the square, operates the loading angle valve before it closes the breech; thus the power to control the elevation of the gun is restored to the gun-layer whilst the breech is still open, and the time occupied in closing the breech and "making ready" is ample to lay the gun. It ought perhaps to be mentioned here that the breech mechanism can be operated at any angle of elevation. No time is lost, for the turret trainer, as already explained, with an independent sight keeps the direction on during the loading. The gun-layer then simply lays his sights in the vertical plane without having to hunt for the target.

Motion No. 3 (Fig. 3).—The loading cage may be brought up if it be properly loaded and if the gun be in the loading position with the breech open, but it is necessary to provide safety arrangements to ensure that these conditions have been fulfilled. Therefore the lever cannot be put over to hoist the cage until a safety bolt A—Figs. 1 and 3—in the lever orbit is removed by the man who loads the cage (in the working chamber below the gun-house), and even if the bolt be withdrawn and the lever put over, the cage will not come up unless the gun is in the loading position with the breech open, because automatic interlocking gear is provided to ensure these motions being complete before the hoist valve comes into action. Similar provision is also made to prevent the cage from coming up unless the gun is run completely out. Running out should take place automatically after recoil. It is well to mention here that the operator commences to work his churn lever directly recoil is finished, so that the running out motion goes on at the same time as the breech is being opened.

The gun-loading cage ought to be loaded in the working chamber before it is required for the loading; therefore the safety bolt ought to be withdrawn, allowing the operator to perform three motions of the churn lever without a check.

Motion No. 4 (*Fig. 4*).—When the shot is in front of the rammer, M, the latter can be given a full stroke to force the shot home. To ram ammunition into the gun it is necessary to move the lever in the same direction as it is desired that the rammer shall work. But the lever cannot be moved forward unless the cage be up in position. This interlock, combined with its fellow, which prevents the cage being lowered if the rammer be advanced, is common to all hydraulic mountings.

Motion No. 5.—The reverse of No. 4 withdraws the rammer. We must here anticipate the description of the ammunition cage by mentioning that it has three floors, on the lowest of which is placed the shot or shell and on each of the others half a charge of cordite. During the last few inches of withdrawal the rammer head strikes and releases a pawl or catch, thus allowing the carrier in the cage to drop one stage and bring the first half of the cordite charge in front of the rammer head. At the same time a bolt—see Fig. 2—is protruded to limit the next forward stroke of the lever—Motion No. 6—and thereby also the travel of the rammer, which now goes forward only far enough to place the half cordite charge just inside the gun chamber.

Motion No. 7.—The lever is again pulled back, withdrawing the rammer again. The latter releases another pawl or catch, allowing a second dropping of the carriers, thus bringing the second half cordite charge into position.

Motion No. 8.—A further forward motion of the lever up to the stop rams in this half charge, pushing the first half charge in front of it, to the same limit, and the gun is loaded.

Motion No. 9 withdraws the rammer for the last time.

Motion No. 10, which is the reverse of No 3. lowers the cage. During the last part of its descent the carriers are returned into position ready for recharging.

Motion No. 11—the reverse of No. 2—releases the gun from its loading position, as already explained.

Motion No. 12—the reverse of No. 1—closes the breech.

Further explanation of the loading cage, the second of the two lifts mentioned in our opening remarks, is now necessary in order that this very ingenious piece of machinery may be appreciated. It is composed of two principal parts, which may respectively be called the containing frame and the sliding frame.

The wire for hoisting the cage, with its usual safety gear—to prevent the cage from falling if the wire breaks—is attached to the back of the containing frame, where are also found the runners for engaging with the curved rails which guide the cage into position. The sliding frame, as already said, is fitted with three carriers or trays, the lower one for the projectile, the two upper trays each for a half charge of cordite. When the sliding frame is within the containing frame it is held in place by a pawl engaging successively with one of two stops. When the pawl is engaged with the lower of these the sliding frame is in position for the ramming of the projectile. When it is engaged with the upper stop the lower half charge is in position for ramming, and, finally, when the pawl is withdrawn altogether the upper half charge comes opposite to the rammer. The pawl can only be withdrawn by the rammer after it has traveled at least the full length of the carriers or trays. If, therefore, the rammer be given a short motion which has not pushed the projectile or half charge into the gun and entirely off the tray, the pawl holding the sliding frame is not withdrawn, so there is no possibility of the frame falling and catching a projectile or charge partly on the tray and partly in the gun. When the cage is lowered the sliding frame, which will be projecting downwards from the cage, first comes into contact with the structure in the working chamber, and, being arrested, the frame slides over and envelopes it until, the motion being complete, the pawl is again engaged with the lower stop.

With the sliding frame thus placed the trays for the half charges of cordite are completely enclosed and the explosive entirely protected, but the projectile tray remains below the containing frame. A door on the front of the cage opens automatically only when the cage is in the position for receiving a charge from the central ammunition hoist. The chances of an accidental explosion are therefore reduced to a minimum. Moreover, doors on the side of the trunk in the working chamber remain closed until the cage is in position opposite them, so that a back flash in the gun-house cannot find its way down the trunk to the magazine.

The advantages of rapidity obtained by this form of gun-loading cage have already been explained, but other very important advantages can be claimed for it. (1) A lever—and one which is generally found rather troublesome to work—is entirely dispensed with. (2) It is impossible to drop a cordite charge on to a moving rammer, an accident which cannot be said to be rare with previous types of gun machinery and which causes grave inconvenience and delay, not to speak of some danger. (3) The cordite charges, which are the most delicate element in connection with the working of heavy guns, are carefully treated instead of being allowed to drop through considerable spaces, as in cages of most existing types. (4) This advantage is combined with an avoidance of any uncertainty as to dropping into the correct position in front of the rammer, a matter of very great importance, especially in connection with loading at a considerable angle of elevation, when it is a fairly common occurrence with existing mountings for quarter charges to foul each other.

The fall of the sliding frame is controlled by an oil buffer, so constructed that it cannot leak or require attention; it entirely prevents any blow or shock being given to the sliding frame as it falls. We have only to add that a cage of this design has, we are informed, been subjected to very severe trials, which have proved that it can be relied upon.

The central hoist bringing the ammunition from the shell rooms and magazines to the working chamber is provided with means for securing the proper relative positions of the projectile and charge. At the bottom of the hoist the projectile receptacle has to be some 6 ft. or 8 ft. below the receptacles for the charges see the drawings * * * [pages 80 and 81]—in order that the former may be conveniently loaded from the shell room and the latter from the magazine handing room. But when the central cage is "up," the receptacles must be close together; in other words, during the motion of hoisting, the shot receptacle must gradually approach the receptacles for the charges. This motion is obtained by a steel wire rope purchase, so simple that it can hardly get out of order, and so little stressed that there is no chance of its breaking and very little of its stretching. Ready means for adjusting for stretch are, however, supplied, as well as the usual apparatus to prevent the cage from falling should the wire rope break.

The one lever principle is employed also in the working chamber for controlling the central hoist, and the rammer used for transferring the projectile and charges from the waiting trays to the gun-loading cage. It is therefore impossible to hoist the central cage unless the rammer valve is in the position for withdrawal.

There is one more fitting in this mounting which well deserves description. We allude to the combined tray and door in the shell rooms and magazine handing rooms used for the admission of the charges and projectiles into the central hoist. In previous mountings the fittings for this purpose have always taken the shape of a sliding door and a tray or bogie. The projectile was placed on the latter, and when it had to be transferred to the central cage the door had to be lifted, then stops were removed, and the projectile rolled down an incline into the cage. The new fitting consists of a door with a curved tray pivoted on brackets fixed to the trunk at each side of the opening. When in position to receive a projectile this door closes the aperture, but when the projectile has to be transferred to the central cage the tray is tipped up, swinging on a horizontal axis which is so placed that the action of tipping does not appreciably raise the center of gravity of the projectile. When the projectile is discharged into the cage the door returns to its original position, closing the aperture, under the action of a spring. The whole process of transferring a projectile from the tray to the cage can be done in less than one second, and is effected by a lever at the side of the door.

If the ship were going into action, one charge would be in the gun, a second in the gun-loading cage, a third in the waiting position in the working chamber, a fourth in the central cage, a fifth on the tray, a sixth and a seventh on runners on the circular rail which feeds the tray. Therefore from each gun seven rounds could be fired without taking a single shell from the shell room bays, and these seven rounds could all be discharged by a gun-layer in less than three minutes. If the ship carried ten guns she could discharge seventy rounds in three minutes.

Let us turn for a moment to the sighting, elevating, and training arrangements which give precision to this formidable discharge. We have already explained that the right gun of the turret is elevated and fired from the right-hand position, the left gun from the left-hand position, and that the turret is trained from a center position between the guns. There is a second center position from which either or both guns can be trained and elevated, but this is only a "spare" position. The gun-layer's sights call for no special remark, but his elevating lever is of interest. It works about a pivot below him, the lever standing vertically when the elevating control valve is centered. The gun-layer pushes the lever from him when he depresses the guns, or draws it towards him when he elevates. Exhaustive trials clearly demonstrated this motion to give the best results. These trials were carried out with a rolling practice platform, a rifle, and a target. Levers and wheels of all descriptions were tried, but under every condition the vertical lever came out best. A lever also offers an advantage in that it is easy to apply a very simple firing trigger to the handle end, so that the gun-layer need not shift his hand to fire when he has adjusted the elevation.

The turret trainer, as already explained, is given a balanced telescope which is independent of any motion of the guns. It can be adjusted for deflection in the horizontal plane, and, being carefully hung in its pivots, the mere pressure of the face against the eye-piece with the help of a pad resting on the head and attached to an arm extending from the telescope is enough to control the telescope and keep it directed, however much the ship may roll. The trainer therefore has both his hands free to manipulate the training wheel, and is thus given every facility to keep his turret and its guns trained on the target.

We have now followed, as far as the limitations of a newspaper article will permit, all the operations of loading, aiming, and firing the guns of a large naval mounting. In conclusion, we must not omit to notice how admirably hydraulic power lends itself to the performance of the powerful but delicate duties it is called upon to perform in handling large guns. Elswick is of course the home of the hydraulic mounting, which has been brought to an astonishing state of development. In the present case, for example, nearly everything is done hydraulically, even the interlocking of the levers and valves—which is so essential to the safe working of the whole complex machinery—being, with only one or two exceptions, effected hydraulically. One of the little cylinders for working the releasing stops may be seen in the first three views of the churn lever. In this connection the total absence of lettered indicators in the mounting we are discussing should be observed. It is usual in mountings of this sort to see such indicators freely distributed to warn the operator that things are "ready" or "not ready," are "up" or "down," and so forth. In the new mounting the former "ready" and "not ready" form of indicator is replaced by definite stops, so that instead of the operator being told not to perform some operation he is actually prevented from performing it. For the "up" and "down" class of indicator, of which there is only one required in the new mounting, the usual railway semaphore signal is used. This simple adaptation is a great assistance when construction of gun machinery for various nations, all using different languages and often difficult notation, has to be considered.

In many cases the hydraulic power can be used by direct straight-line movement, as in the elevating gear and the shot hoists; in other cases, as for the rammer and so on, a rotary motion is required. In such cases a swash plate hydraulic engine, one of which can be seen * * [page 80], is employed. We are informed that this type of motor has entirely replaced the older three-cylinder Armstrong form, and gives perfect satisfaction.

Looking at the mounting as a whole, we must confess that this is a case where electricity could hardly expect to compete with the older power. The perfect control of speed which is peculiar to hydraulic machinery cannot, as far as we are aware, be secured with the same ease and certainty in any other way, whilst there is an entire absence of such small and sometimes delicate parts as electricity requires. With hydraulic machinery everything not only may, but must, be made solidly. When one sees the way a mounting is handled, one grasps the necessity of having all details of a very substantial kind. It may be a solace to the electrician to know that he is not wholly forgotten, for an electrically driven pump is provided as a stand-by in case the main hydraulic supply should be cut off. Furthermore, electric firing is used and the turret is lighted with electric lamps.—*The Engineer* (London).

DREADNOUGHT DEVELOPMENTS, 1905-1913

By Percival A. Hislam

One hundred months have passed since the British Admiralty definitely decided upon the construction of the *Dreadnought*, and this period has witnessed a series of developments in the design and equipment of capital ships which are not less striking because they include nothing revolutionary. The *Dreadnought* introduced a new governing principle into battleship design, a principle usually expressed in the phrase "single caliber" or "all big gun" armament. The underlying idea was that only one caliber of gun should be mounted in capital ships for use against any type of opposing vessel above the grade of a destroyer. The soundness of that idea has never been unanimously admitted abroad, and there are signs that the British Admiralty is beginning to compromise upon it.

The most conspicuous of the many results that have followed directly from the building of the *Dreadnought* are intensified naval competition in its wide sense, and a keener rivalry among the principal Powers for the possession of the largest and most powerful individual units. It is not proposed to discuss here the general aspects of naval competition, but it will not be without interest to give a brief series of figures showing how great has been the upward trend of naval expenditure since 1905, which is, at least in part, attributable to the impetus exerted by the *Dreadnought* as a result of its providing a fresh starting-point for international maritime rivalry. The following is a comparison between the naval expenditure of the principal Powers in 1905 and their estimates for 1913:

	1905 £	1913 £
Great Britain	33,389,000	46,309,300
United States	22,594,612	28,932,630
Germany	11,424,845	22,887,870
France	12,743,932	18,626,755
Russia	12,149,692	24,477,487
Japan	2,400,000	9,860,912
	94,702,081	151,094,954

This represents a total increase for the six Powers in eight years of 59.5 per cent.

A strongly marked feature of the *Dreadnought* era has been the increase of ship-power at the expense of fleet-power. Attention has been concentrated on the development of the capital ship in pursuance, apparently, of the idea that the capital ship is the battle unit. Such is not the case. The fleet is the battle unit, and no fleet is properly so called unless it is provided with an adequate complement of cruisers, destroyers, and other auxiliary craft, for these alone can ensure the ability of the capital ships to carry out their main business—the interception and destruction of the enemy's capital ships. The destroyer has not suffered from any great neglect during the *Dreadnought* era except, rather curiously, at the hands of Russia and Japan. As regards cruisers, however, Great Britain has, during this period, launched only 22 to a total of 28 capital ships, while for the United States Navy not a single cruiser of any description has been launched since 1907. The small cruiser has suffered even greater neglect at the hands of the French naval authorities, no vessel of the type having been launched since the *Jurien de la Gravière* in 1899. That this policy was a mistaken one is now admitted, at any rate by Great Britain and France, eight small cruisers having been provided for by the former in 1912-13 and again in 1913-14, while the French Ministry of Marine has under consideration the plans of scout-cruisers of about 6000 tons and a speed of 27 to 30 knots.

The increased segregation of naval power in the individual unit has naturally resulted in all-round advances in the various factors that go to make up individual fighting strength. While the caliber of the main armament remained stationary—which was not for long—there was a general increase either in the number of guns mounted or in the number available for broadside fire. This was followed by the substitution of guns of greater caliber, and here again the same tendency to increased numbers became discernible, though not nearly to the same extent as before. Armor thicknesses, speed, horse-power, fuel endurance—all these have advanced, with a corresponding increase in tonnage and cost. If we take the era of pre-*Dreadnoughts* properly so-called as beginning with the period of the *Majestics* and ending with that of the *King Edwards*, it will be found that the advance in displacement in all the great navies was comparatively moderate. In 1895-6 there were launched for the British, United States, German, French and Japanese navies sixteen battleships totalling 210,820 tons, an average of 13,176 tons per ship. In 1904-5 the same Powers launched twenty-four battleships aggregating 359,923 tons, an average of 14,997 tons per ship. The average increase in displacement was therefore no more than 13.8 per cent.

In the *Dreadnought* era the expansion of dimensions has already exceeded this very considerably. The details as regards the latest ships are not available, and it is better to leave them out than to select one of the more or less haphazard "estimates" that are always made in such circumstances. In the following table, therefore, the tonnages of the first *Dreadnoughts* built for the respective navies are compared with those of the latest ships for which reliable figures are available. The year given is in each case that of the laying down of the first of the class.

	First ship	Latest ship	Increase
Great Britain	*Dreadnought* (1905)	*Iron Duke* (1912)	39.7 p.c.
	17,900 tons.	25,000 tons.	(7 years).
United States	*Michigan* (1906)	*Pennsylvania* (1913)	93.7 p.c.
	16,000 tons.	31,000 tons.	(7 years).
Germany	*Nassau* (1907)	*Kaiser* (1909)	30.7 p.c.
	18,600 tons	24,310 tons.	(2 years).
France	*Courbet* (1910)	*Normandie* (1913)	7.4 p.c.
	23,100 tons.	24,800 tons.	(3 years).
Italy	*Dante* (1909)	*Dandolo* (1913)	44.3 p.c.
	19,400 tons.	28,000 tons.	(4 years).

The first noticable tendency in *Dreadnought* design aimed at increasing the actual or proportionate power of the broadside by adding to the number, but not to the caliber, of the guns available on the beam. Germany provides an exception in having advanced from the 11-inch guns of the *Nassaus* to the 12-inch of the next group, the *Helgolands*, but as this simply brought her into line with foreign Powers it need not be regarded as an increase of caliber in the sense with which we are now dealing with the subject. The first *Dread-*

noughts built for Great Britain, Germany, the United States and Japan all had eight guns bearing on the broadside; but there were great differences in the aggregate power required to produce the broadside. The American *Michigan* and *South Carolina* obtained it with a total armament of eight big guns, having four twin turrets mounted on the center line. The *Dreadnought* needed ten guns, having only three turrets on the center line and two abreast on the beams. The German and Japanese ships were, from this point of view, the most expensive, for they all have six twin turrets to produce an eight-gun broadside, two turrets only being on the center line, the other four being placed in pairs abreast on the beams. The "broadside efficiency" of the various types—that is, the relation of the broadside to the total armament—was therefore 100 per cent in the American ships, 80 per cent in the British, and 66.6 per cent in the German and Japanese.

It is beyond question that the American plan as adopted in the *Michigan* was and remains the most efficient means for distributing four turrets, and the Navy Department have expressed their appreciation of the fact by copying the system in the *Nevada* and *Oklahoma* (armament ten 14-inch) and the *Pennsylvania* (twelve 14-inch). The former pair will have two triple turrets, one forward and one aft, with a twin turret superposed behind each; while the *Pennsylvania* will have four triple turrets similarly disposed. It is believed that the British Admiralty has adopted this arrangement in the ships of the *Queen Elizabeth* class, Germany in the *Ersatz Worth* and "*T*," and Italy in her newest designs, the main armament in each case being eight 15-inch guns. Whether this is the case or not, however, the American naval authorities have reason to be proud of the fact that, at least, the example they set of mounting all the main guns on the center line has now been adopted by every naval Power.

Up to the present, the artillery development of American *Dreadnoughts* presents more points of interest than in the case of any other nation because it has been so thoroughly coherent. The *Michigan* and *South Carolina* had eight 12-inch guns in four turrets. They were followed by the *Delaware*, *North Dakota*, *Florida*, and *Utah*, with ten in five turrets, and these by the *Wyoming* and *Arkansas* with twelve in six turrets. The arrangement of the turrets—which are all on the middle line—is simply shown in the following manner, "a" representing the first from forward, "b" the second, and so on; while a capital letter indicates that the turret is superposed. The double line (||) represents the superstructure.

Michigan class....................	aB||Cd
Delaware class....................	aB||Cde
Wyoming class....................	aB||CdEf

The *Wyomings* were the last American vessels to mount the 12-inch gun; the adoption of the 14-inch weapon in the *New York* and *Texas*, of the 1910 programme, was due principally to the fact that the 13.5-inch had been mounted in the British *Orion* and *Lion*, and that similar developments were contemplated in other fleets. To a large extent, however, the reason for the change undoubtedly lay in the fact that any further increases in power, if the 12-inch gun had been adhered to, would have involved an extortionate increase in tonnage and cost. In everything except gun power the *Wyomings* are identical with the *Delawares;* but the increase of 20 per cent in gun power (from 10 guns to 12) involved the raising of the displacement from 20,000 to 26,000 tons, or 30 per cent. The *New York* and *Texas*, with ten 14-inch guns, have their turrets arranged thus: aB||cDe; that is, they differ from the *Delawares* in having the center instead of the first of the three after turrets superposed.

In subsequent American ships a return has been made to the principle of the *Michigans*—that is, there are four turrets only on the center line, two forward and two aft. This has necessitated the adoption of the three-gun turret as regards six of the ten 14-inch guns in the *Oklahoma* and *Nevada*, and as regards the twelve 14-inch of the *Pennsylvania*. The development of the American 14-inch gun *Dreadnoughts* may therefore be expressed thus:

	Disposition of guns	Broadside	Tonnage
New York................	a2 B2||c2D2e2	14,000 lb.	27,000
Nevada..................	a3 B2||C2 d3	14,000 lb.	27,500
Pennsylvania.............	a3 B3||C3 d3	16,800 lb.	31,000

(The figure following the letter which indicates the turret shows the number of guns in the turret.)

In the British Navy the "all on the center line" arrangement for the main turrets was not adopted until fourteen *Dreadnoughts* had been built otherwise. The first seven battleships—*Dreadnought, Bellerophon, Téméraire, Superb, St. Vincent, Collingwood* and *Vanguard*—were identical in this respect, having three turrets on the long arm of a cross (the middle line of the ship) and two on the short arm. The first move towards the American system was made with the *Neptune*, laid down in 1909, in which the short arm of the cross was slightly slewed, the port side towards the bows, so that the turrets lying upon it have a small arc of fire on the beam opposite to that on which they are placed. In order to minimize the increase in length which would otherwise have been the result of this, the second turret from aft was raised so as to be superposed behind the aftermost. This was an improvement on the earlier vessels, but it still left much to be desired in comparsion with the American system, as the arc of training for the ten guns together was much less in comparison. Two more ships—the *Hercules* and *Colossus*—were, however, built on the same principle; but they were the last British battleships which had a turret off the middle line, and also the last to carry the 12-inch gun. The *Orion*, laid down in 1909, has ten 13.5-inch guns in five center line turrets arranged thus: aB||c||De. The *Orion* has three sister ships (*Thunderer, Conqueror,* and *Monarch*), and the shell fired by their main guns has a weight of 1250 lbs. This group was followed by the *King George V, Centurion, Ajax,* and *Audacious* (1910-11 programme), and the *Iron Duke, Marlborough, Benbow,* and *Delhi* (1911-12 programme), all of which have the same nominal main battery. In the later vessels, however, the 13.5-inch gun is of a greatly improved type, the shell having been lengthened so as to give a weight of 1375 lbs., the greater part of the increase being used to give a heavier bursting charge. It is believed that there is an increase of an inch and a half (to 13½ inches) in armor thickness between the *Orion* and the *Iron Duke*, and it is stated that a further advance has been made, to 15 inches, for the main belt of the *Queen Elizabeth, Warspite, Barham,* and *Valiant*, whose main armament is to consist of eight 15-inch guns, with a speed of 25 knots. It may be mentioned in passing that Great Britain stands alone among the naval Powers in never having put more than ten big guns into her Dreadnoughts.

The design of German *Dreadnoughts* has apparently suffered from two causes; first, the lack of initiative on the part of those responsible, and, second, conservatism in the matter of armament. These defects have not been lessened in the estimation of observers by the evident desire of the authorities to cloak them, or by the frequent assertions that what appeared to be bad was in reality the best obtainable. The first batch of German all-big-gun battleships—the *Nassau*, *Westfalen*, *Rheinland*, and *Posen*—were given a main armament of twelve 11-inch guns, of which only eight were available for fighting on the beam. The same arrangement was repeated in the *Helgoland*, *Ostfriesland*, *Thuringen*, and *Oldenburg*, but with the difference that the 11-inch gun, which had been strongly asserted in semi-official publications to be fully equal to any foreign weapon and to be quite adequate for Germany's needs, was replaced by the 12-inch. It was further declared in answer to various criticisms that the idea that the whole of the main armament should be available for use on either broadside was faulty, and made no allowances for the probable contingencies of war. In view of these statements, it is pertinent to note the comparison between the *Helgolands* and the *Kaisers*, by which they were followed. The *Kaisers* displace 24,310 tons as compared with the 22,440 tons of the preceding vessels; they carry the same secondary battery (14 5.9-inch), and have machinery of 3000 h.p. less. As regards the main armament, however, the ideas of the German authorities had evidently undergone some modification, for it was deemed advisable to reduce the number of big guns from twelve to ten in order that the number available on the beam might be increased from eight to ten, even though an increase of 2000 tons in displacement was involved. The guns of the *Kaisers* are arranged similarly to those of the *Neptune*.

An extensive series of rumors have at one time or another been circulated as to the armament of later German ships. A prominent London "daily" announced after the *Kaiser* was completed that she carried 14-inch guns, while for other ships suggestions of twelve and thirteen 12-inch and ten 14-inch have been frequent. It is now fairly certain, however, that no change was made in the design of German battleships between the *Kaiser* and *Friedrich der Grosse* of the 1909-10 programme, and the *Ersatz Brandenburg* provided for in 1912-13, which would give a total of nine ships identical in design. The *Ersatz Worth* and "*T*," of the 1913-14 programme, are stated semi-officially to carry eight 15-inch and sixteen 5.9-inch.

The three nations dealt with above,—Great Britain, Germany, and the United States—are the only ones that have built anything like a large number of *Dreadnoughts* distributed over various designs. The following is a summary of the advance that has been made in broadside fire from big guns; the types are arranged in chronological order for each Power, but those in any given line are not necessarily contemporary:

	British	Lbs.	United States	Lbs.	Germany	Lbs.
1. Type	*Dreadnought*		*Michigan*		*Nassau*	
Broadside	8 12-in.	6,800	8 12-in.	6,960	8 11-in.	6,080
2. Type	*Bellerophon*		*Delaware*		*Helgoland*	
Broadside	8 12-in.	6,800	10 12-in.	8,700	8 12-in	7,848
3. Type	*St. Vincent*		*Florida*		*Kaiser*	
Broadside	8 12-in.	6,800	10 12-in.	8,700	10 12-in.	9,810
4. Type	*Neptune*		*Wyoming*		—	—
Broadside	10 12-in.	8,500	12 12-in.	10,440		
5. Type	*Orion*		*New York*		—	—
Broadside	10 13.5-in.	12,500	10 14-in.	14,000		
6. Type	*K. George V.*		*Nevada*		—	—
Broadside	10 13.5-in.	13,750	10 14-in.	14,000		
7. Type	*Q. Elizabeth*		*Pennsylvania*		—	—
Broadside	8 15-in.	15,600	12 14-in.	16,800		
8. Type	1913-14		—	—	*Ersatz Worth*	
Broadside	10 15-in.	19,500			8 15-in.	13,404

As showing how misleading it would be to regard the horizontal lines as containing contemporary vessels, it may be pointed out that the most recently completed types in the three fleets are the British *King George V*, the American *Wyoming*, and the German *Kaiser*. In each case there has from first to latest been an increase in broadside fire of well over 100 per cent, due almost entirely to the adoption of a larger caliber gun. There has been, and will probably continue to be, a good deal of quiet controversy as to whether it is better to have a few "biggest possible" guns, or a correspondingly larger number that are "big enough." Increased calibers give a larger percentage of hits—the difference between the American 12-inch and 14-inch was 30 per cent in favor of the latter at long ranges; but the rate of fire is reduced as well as the number of guns that can be mounted on a given displacement. The problem—which is not an easy one—may be set down thus: Is it better to rely upon an increased percentage of hits to rounds, or upon firing more rounds with a stationary percentage? Admiral Sir Reginald Custance has made a notable contribution to its solution in *The Ship of the Line in Battle*, a work which is no doubt being studied by every one with any interest in naval affairs. His conclusions are in favor of the many that are "big enough," and against the few that are the "biggest possible," and so are opposed to the practice of nearly every naval Power, since a shell of 1000 lbs., representing a gun of between 12-inches and 13-inches caliber, is probably "big enough" on the basis of modern armor and probable battle ranges.

It will be seen that in the table [page 95] the armament of the British ships of the 1913 programme is assumed to be ten 15-inch. There is no direct official authority for this, for which only the following reasons can be advanced, albeit they appear fairly conclusive. In March last the First Lord of the Admiralty stated that the *Queen Elizabeths* would cost a little more than the *Tiger*—say, £2,250,000. In July when attacking the criticisms of the Opposition, he declared that our new ships were costing 2¾ millions each, though the statement was made in a casual manner and was not generally noticed. If eight guns are mounted in ships costing 2¼ millions, the addition of £500,000 to the cost warrants the assumption that two additional guns will be mounted.

There are some interesting features in the main armaments of the *Dreadnoughts* of the lesser Powers which should be noticed here. France —which must, unfortunately, be reckoned among these for the time—began late with the *Jean Bart*, *Courbet*, *France*, and *Paris*, which are armed with twelve 12-inch in six turrets, four on the center line and one on either beam, the former being arranged as in the *Michigan*. These were followed by the *Bretagne*, *Lorraine*, and *Provence*, carrying ten 13.4-inch on the same plan as the *Orion*. The four ships to be laid down in the current year strike out quite a new line, however, for they are to carry twelve 13.4-inch in three quadruple turrets on the center line. The arrangement suggests that the element of freakishness has not yet been eliminated in France, but the result will be watched with interest. Some notable developments are also promised in Italy—the mother of the monster naval gun, of the "mastodon" battleship of the eighties, and of the *Dreadnought*, as well as of the three-gun turret. The first Italian *Dreadnought*, the *Dante Alighieri*, has four triple turrets with 12-inch guns on the center line. During the next few months there will be completed the *Conte di Cavour*, *Leonardo da Vinci*, and *Giulio Cesare*, which have thirteen 12-inch in five center line turrets arranged thus:—a3B2||

c3||D2e3. Two more vessels of the same design, the *Andrea Doria* and *Duilio*, were laid down early in 1912; two others (*Morosini* and *Dandolo*), about to be laid down, are to carry ten 14-inch on the same plan as the *Nevada* (a3 B2||C2 d3). The design of the battleships to be laid down in 1913 has been the subject of much discussion. The Council of Admirals proposed a type of 35,000 tons armed with twelve 15-inch guns. At the request of the Cabinet, this was reduced to a displacement of 29,000 tons and an armament of nine 15-inch. Triple turrets were to be used in both cases. It is now announced that four vessels of 25 knots armed with eight 15-inch guns will be built.

The only other vessel which calls for special mention here is the Brazilian battleship *Rio de Janerio*, now completing afloat at Elswick. Her guns are of 12-inch caliber, and her armor is only 9 inches thick, so that, rightly or wrongly, she is not likely to influence future designs in any way. The only feature of interest is that her main battery is made up of no fewer than fourteen heavy guns, all in twin turrets on the center line, the arrangement being as follows: a B||cd||eFg.

Throughout the *Dreadnought* era the tendency with regard to secondary or anti-torpedo armaments has been to increase them as regards either number or caliber, or both. Great Britain began by giving the *Dreadnought* twenty-four 12-pounders, and a similar mistake was made by the United States, whose *Michigans* have twenty-two 3-inch only besides the 12-inch. In all subsequent British ships down to the *King George* class, however, the 4-inch 31-pounder has been mounted, the number being sixteen in every case with the exception of the three *St. Vincents*, which originally had twenty and now have eighteen. Later battleships are to have twelve or more 6-inch, and with the reduction in the number of primary guns from ten to eight, it is a reasonable expectation that we shall shortly witness the return of the 9.2-inch gun into battleship armament. Already we seem to have got back to the logical development from the *King Edwards*. These ships were armed with four 12-inch, four 9.2-inch, and ten 6-inch guns as compared with the four 12-inch and twelve 6-inch of their immediate predecessors. The next evolutionary step would have been the replacement of the 9.2-inch by 12-inch guns, the 6-inch battery being retained; and this, after making allowance for contributory developments in the meantime, is what is represented by the *Queen Elizabeths* with their eight 15-inch and sixteen 6-inch.

The United States has adhered to the 5-inch gun from the *Delawares* onwards, but the number has been steadily increased, fourteen being mounted in those ships, sixteen in the *Floridas*, twenty-one in the *Wyomings* and *Nevadas*, and twenty-two in the *Pennsylvania*. All German *Dreadnoughts* have the 5.9-inch guns in their secondary battery, besides a number, usually sixteen, of 3.4 inch, the number of the former having been increased from twelve in the *Nassaus* to fourteen in later ships, and sixteen in this year's. France is placing twenty-two 5.5-inch in all her *Dreadnoughts* down to and including the *Lorraines*, but the *Normandies* are to have twenty-four. Italy has advanced from twenty 4.7-inch in the *Dante Alighieri* to an equal number of 6-inch in the *Morosini* and *Dandolo*, and in this year's ships. Guns of the same caliber have been mounted in all Japanese *Dreadnoughts*, while the *Rio de Janerio* will have twenty of them. It will be seen that opinion is fairly unanimous in favor of a 5-inch or 6-inch gun in the anti-torpedo battery; but as these things seem to be governed more by a desire to "go one better" than anybody else rather than to produce a ship in agreement with tactical and strategical requirements, it is probable that the near future will witness the development of the anti-torpedo battery into a secondary battery proper; and as this would necessitate the introduction of a new anti-torpedo battery we should be back once again in principle to the pre-*Dreadnoughts* with their three types of guns—one for use at extreme ranges, one for use in conjunction with them at decisive ranges, and one in the anti-torpedo battery. This is the ideal warship armament of many men in the many navies.

Before leaving the subject of armament, mention must be made of the growing importance of the torpedo, as represented in battleship design. The *Dreadnought* had five tubes, but the number was reduced to three in the *Bellerophons*, and remained the same down to the *Iron Duke* class, in which (and in later ships) four are mounted. Germany, always more lavish in this direction than Great Britain, equipped all her *Dreadnoughts* down to the *Helgolands* (and indeed all her battleships from the *Wittelsbachs* onwards) with six tubes, and was reported to be increasing the number to eight in the *Kaisers* and later classes. Actually, however, these ships will have only five. Only two tubes are mounted in United States *Dreadnoughts* down to the end of the 12-inch gun era, but later ships have four; while France placed two in her last pre-*Dreadnoughts*, four in the first *Dreadnoughts*, and six in the *Normandies*. An all-round advance is seen here, due, without doubt to the fact that the range of the modern Whitehead is quite equal to the assumed decisive range of a naval action.

In the matter of armor, the general trend is unquestionably towards a return to that type of battleship uncomplimentarily known as "soft-ended." The British *Dreadnoughts* with 12-inch guns have continuous belts, tapering to 6 inches forward and to 4 or 5 inches aft. In later types, however, the extremities are quite unarmored, and the belt as far as it extends beyond the end barbettes does not exceed 4 inches. The reason for the circular movement back to the armor principles of the old *Dreadnought* of 1875 is so obvious that the wonder is that any *Dreadnoughts* should have been burdened with thin armor. Anything less than 12 inches in thickness is useless against battle guns at extreme ranges, and at decisive ranges it is doubtful whether armor of any practicable thickness will be of much use; so that while 12-inch armor may have some defensive value, it is certain that none attaches to 4, 5, or 6-inch, which probably confers an advantage on the attack in sufficing to burst his shells when otherwise they might have passed through more or less harmlessly. No armor details for British ships are definitely known beyond the *King George* class, which have 12-inch belts, unarmored extremities and thin (and therefore useless) belts carried some distance beyond the extreme turrets. Rumor credits the *Queen Elizabeth* class with 15-inch main belts, which must necessarily entail the reduction of the effectively armored area; but the main points to be noted with regard to the armor question are these: First, even 15-inch armor does not ensure protection against the 13.5 inch gun—to take what is now a medium caliber —at decisive ranges; and, second, as the thickness of the armor increases so must the proportion borne by the armored area to the target presented be reduced, with a corresponding diminution in the value of the armor. If one-third of the target is invulnerably armored—and that is a high ratio— two shots will strike the vulnerable parts for every one that hits the impenetrable armor. The abolition of armor for all except big gun positions has been advocated by many men at various times, and is a possibility of the future.

As in the case of armament, American armor developments present many points of interest, though this may be due largely to the fact that full details are published officially. Down to and including the *New York*, there are no striking features to be noticed, but the complete substitution of oil fuel for coal in the *Nevada* and *Oklahoma* resulted in an enormous saving of weight, which was used entirely to increase the protection. The ships are 583 feet in length, and the belt is just over 400 feet long, so that nearly one-third of the length is entirely unprotected. The main belt is 17½ feet deep, 9 feet being above the water-line. The thickness at the upper edge is 13½ inches, and at a distance of about four feet below the water-line it begins to taper off until a minimum thickness of 8 inches is reached. At a point about 30 feet beyond the after barbette the above-water armor ceases, and for the remaining 60 feet of its length the upper edge of the belt is coincident with the water-line. The extremities of the belt are joined by 13-inch bulkheads, so that the ship may be said to be built about an oblong box whose sides are 17½ feet deep (except at the after end) and 13-13½ inches thick. The 5-inch guns are not protected by any armor whatever. The faces of the triple turrets are 18 inches thick, and of the twin turrets 16 inches, while all have 9-inch backs and 5-inch roofs. The conning tower and the main communication tubes have 16-inch walls. In the matter of armor, the *Pennsylvania* will be practically a replica of these ships, with 14-inches in place of 13½-inches.

A steady increase is to be noted in the armor thicknesses of German *Dreadnoughts*. The maximum thickness of the belts of the *Nassaus* is 9¾ inches; of the *Helgolands* 10¾ inches, and of the *Kaisers* 12¾ inches. The 1913 ships will, it is believed, have an extreme thickness of 15 inches over a small area. The French *Jean Barts* and *Lorraines* have a maximum thickness of side armor of only 10¾ inches, in order to provide 7-inch ends, and the same principle has been followed in the *Normandies*, which will have ends of the same thickness and a maximum of 12.6 inches amidships.

The development of the battle cruiser has proceeded generally along the same lines as that of the *Dreadnought* battleship, but with a much more pronounced advance in size owing to the demands of high speed. Much has been heard lately about the abandonment of this class of ship by the Admiralty, and of its amalgamation with the battleship. It is difficult to discover, however, just what is being done. The *Queen Eliazbeths*, which are to have the same speed as the *Invincibles*, are officially termed "fast battleships"; and on July 17th last the First Lord referred to a decision of the Admiralty to build "a division of fast battleships and of battle cruisers." Mr. Churchill stated at the same time that there was no intention to increase the standard battleship above 20 or 21 knots; and, therefore, on the scanty information available, it would appear that the *Queen Elizabeths* are to be the pioneers of a new class of capital ships intermediate in power and speed between battleships and battle cruisers. This seems to be the only inference that can logically be drawn from the First Lord's statements, and it remains to be seen how it will be received by professional opinion. In the meantime, increased speeds are becoming noticeable abroad. The new battleships of both Italy and Austria are credited with a speed of 25 knots, while the Russian battle cruisers *Borodino*, *Navarin*, *Ismail*, and *Kinburn*, understood to have been laid down at the end of last year, will have a speed of 26.5 knots, their displacement being 28,000 tons, and armament nine 14-inch.

Great Britain and Germany alone have laid down a series of battle cruisers, the following being a summary of their principal features. The ships are arranged in chronological order according to the programme in which they were provided for:

	Tons	Length	Designed H.P.	Designed Speed	Main guns	Broadside
Invincible	17,250	530 ft.	41,000	25 kn.	8 12-in.	6,800 lbs.
Von der Tann	19,100	561 ft.	44,000	25 kn.	8 11-in.	6,080 "
Indefatigable	18,750	555 ft.	43,000	25 kn.	8 12-in.	6,800 "
Moltke	22,640	610 ft.	50,000	27 kn.	10 11-in.	7,600 "
Lion	26,350	660 ft.	70,000	28 kn.	8 13.5-in.	10,000 "
Queen Mary	27,000	660 ft.	75,000	28 kn.	8 13.5-in.	11,000 "
Derfflinger	?	?	?	?	8 12-in.	7,848 "

One fact that stands out prominently from all comparisons is the superior gun power of British ships, reckoning this on the ordinary basis, that is to say, the weight of broadside fire from battle guns. So far, Great Britain has provided for thirty-nine *Dreadnoughts* to Germany's twenty-six; and if it be true that the British ships of the 1913-14 programme are to carry ten 15-inch guns apiece, the German *Ersatz Worths* eight 15-inch, and the *Derfflinger, Ersatz Hertha,* and *Ersatz Kaiserin Augusta* eight 12-inch, the comparison between the total armaments of the two fleets will be as follows:

	15-in.	13.5-in.	12-in.	11-in.	Total
Britain	82	152	132	—	366
Germany	16	—	162	86	264

This represents a British superiority in gun numbers of only 38 per cent; but a closer examination shows that the British ships have an advantage in broadside fire of 462,200 lbs. against 223,301 lbs., or no less than 107 per cent.

The *Dreadnought* era has lasted eight years—from the time when the first ship was laid down. Whether it is young or old depends entirely upon future developments. From one point of view, indeed, it is already dead, for has it not produced the "super-*Dreadnought*" and the "hyper-super-*Dreadnought*"? It has increased everything—the size and cost of ships, the caliber of guns, the complements of ships, the personnel of navies, and aggregate naval expenditure. How long can these tendencies be maintained? Theoretically, there is no limit. Engineers can build a ship or a gun as large as any Admiralty might care to order. Men can be obtained for fleets in the same way as most nations find them for their armies. No Power exhibits the least sign of breaking down under the burden of defense expenditure; nor, indeed, is there any reason to believe that outlay would be reduced if the cost of ships were halved. Every nation claims to maintain a fleet for the purpose of preserving peace—a strange argument indeed when we reflect that war is impossible without the means of prosecuting it. The danger that confronts the world to-day is that some nation with little that can be lost and with a great deal to gain may suddenly decide that peace is not worth the cost of maintaining it. It is, in truth, a matter of grave doubt whether anything short of war can check those tendencies, upward in everything save ideals, which are characteristic of the naval era in which we live.

—*United Service Magazine.*

* * *

COMPARISON OF LEAD-SULPHURIC AND EDISON TYPES OF STORAGE BATTERY

By Eugene Oster

The lead-acid battery, due to its priority, has been utilized in all applications where a storage battery can be used; its largest field is for power-house work. Owing to its high efficiency, it is improbable that its supremacy in this field will be endangered by any other type of battery, since a difference of a few per cent in efficiency is usually the determining factor in the selection of a piece of power-plant apparatus.

The Edison battery, while originally intended to fill a need in automobile work, has recently extended its field of usefulness to include a great number of applications. It is now being used in self-contained car service, for propelling mine locomotives, for train lighting and for home lighting in isolated districts. Its largest field, however, has been in the commercial truck service, where light weight, fool-proof construction and simplicity of care render it well suited for traction and portable use and offset its slightly lower efficiency.

The advantages and disadvantages of the two types will be made more apparent by a detailed examination of their respective characteristics; the comparison here intended, including construction, care and management, efficiency, capacity, life and cost.

The Lead Cell

The lead-acid battery consists of two electrodes or sets of electrodes, the positive and negative, immersed in the electrolyte. The two electrodes are sponge lead (Pb), for the negative, and peroxide of lead (PbO_2), for the positive, the electrolyte being dilute sulphuric acid. The hard, velvety brown chocolate-colored positive, and the soft, light gray negative element, are very readily distinguishable.

PLATES

Storage batteries of the ordinary lead-sulphuric type are divided into two general classes—the Planté and the Faure. The Planté type of plate is constructed of solid sheet lead so fashioned as to present a large area to the action of the electrolyte. The active material is formed on the plates, either electrically, by charging and discharging (commonly called "forming") or chemically.

In the Faure type the active material is applied mechanically to lead conducting plates or grids, and for this reason it is commonly called the "pasted" type. The positive plate is made of lead upon which a coating of peroxide of lead has been formed or mechanically applied. The negative plate is of pure lead with a spongy or porous surface, and the plain lead body of each plate serves as a support for the active material.

All the materials of the plates, the grids, spongy lead, lead peroxide, and lead sulphate, are practically insoluble in the sulphuric acid. The electrochemical action which takes place in the cell slowly oxidizes the grids and causes them to disintegrate. The lead sulphate formed during discharge has a greater volume than either the spongy lead or the lead peroxide; consequently, there is expansion and contraction of the active material. The inability of designers to provide for this change of volume has been responsible for many troubles. Moreover, the lead peroxide of the positive plate is somewhat noncohesive, and during the subsequent gassing at the end of the charge some of it falls off, forming sediment, which if allowed to accumulate will short-circuit the plates. This loss of active material, unless compensated by the corrosion of the exposed lead surface to form new lead peroxide, results in a decrease in the capacity of the plate. The spongy lead of the negative plates being quite cohesive does not fall off if the cells are kept free from short-circuits and foreign materials, but it gradually becomes more compact and through the diminution of its porosity its capacity decreases. The rate of this decrease is greatest at the start and finally becomes very small. The negative plates are usually given sufficient initial capacity to provide for this shrinkage.

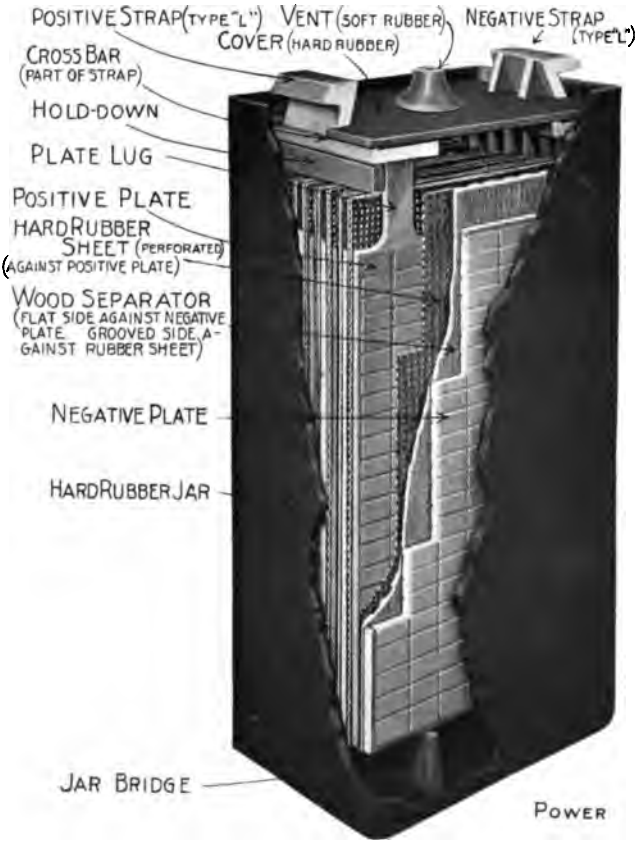

POSITIVE STRAP (TYPE "L")
VENT (SOFT RUBBER)
NEGATIVE STRAP (TYPE "L")
COVER (HARD RUBBER)
CROSS BAR (PART OF STRAP)
HOLD-DOWN
PLATE LUG
POSITIVE PLATE
HARD RUBBER SHEET (PERFORATED) (AGAINST POSITIVE PLATE)
WOOD SEPARATOR (FLAT SIDE AGAINST NEGATIVE PLATE. GROOVED SIDE AGAINST RUBBER SHEET)
NEGATIVE PLATE
HARD RUBBER JAR
JAR BRIDGE
POWER

FIG. 1.
Gould cell partly in section

SEPARATION AND INSULATION

In order to keep the plates apart and thus prevent short-circuits, rod or diaphragm separators are used in all batteries except those in which the plates are covered with hard rubber or celluloid envelopes. Where permanency is desired, the only permissible materials are hard rubber, glass and earthenware.

Wood separators are extensively used, but must be replaced each time the cells are moved. Soft vulcanized rubber cannot be used for permanent work, due to its rapid disintegration in the acid.

ELECTROLYTE

The electrolyte is sulphuric acid, diluted with sufficient pure, distilled water to bring it to the required density, the acid in every instance being poured into the water. The density varies with the condition of the battery and also has a very important bearing on its operation. If it be too high or too low, excessive sulphation is facilitated and the plates are liable to depreciate rapidly. The usual limits in practice are 1.170 to 1.195 when discharged and 1.190 to 1.225 when fully charged.

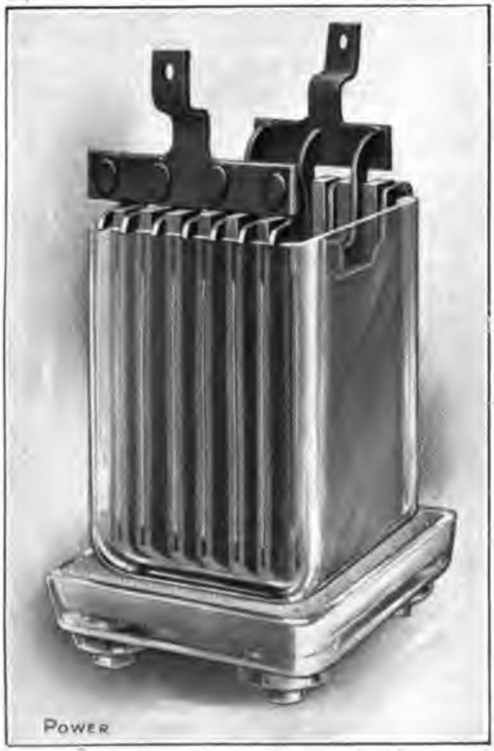


FIG. 2.

Gould battery with glass jar and sand tray

CONTAINING CELL

Rubber and celluloid are used almost exclusively for traction and portable cells; glass is limited to stationary batteries. While the life of a storage battery is much longer when installed in glass jars, because it permits examination of the plates, the cost of the glass and its tendency to crack under temperature changes has caused it to be avoided in large sizes. Because of their high initial cost and short life, glazed earthenware containers have not come into extensive use. Wooden lead-lined tanks are very largely used for large station batteries, but are somewhat expensive.

ASSEMBLING AND INSTALLATION

The individual plates are assembled to form a complete cell, by "burning" to a common lead bar or strip, all plates of like polarity. The cell terminals are then joined by means of bolts or by "burning." The former method is the more expedient, though open to the objections that the bolts must be frequently inspected to prevent loose connections and also that all connections must be protected from the acid spray by a coating of asphaltum or vaseline. The "burning" method requires the service of a skilled workman and special apparatus; hence is rather expensive, though permanent. It also renders the plates less capable of being disassembled for cleaning than does the bolt connection.

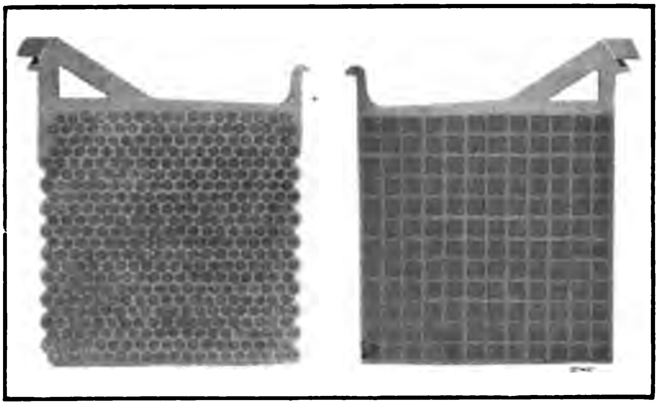


Fig. 3.

"Chloride" positive and negative (box type) plates—Electric Storage Battery Co.

Batteries should be installed in especially prepared rooms, dry and arranged for maintaining a moderate temperature during cold weather. The room should be well ventilated and accessible, and the floor should be covered with asphalt, tile or vitrified brick, and should slope slightly toward numerous discharge drains. All metal work near the batteries must be lead covered, and any metal work subjected to acid fumes should be painted with acid-proof paint.

CARE AND MANAGEMENT

On continuous discharge the one-hour rate should usually not be exceeded, and this should last only a short time, say, 20 min., except in emergencies or in the case of regulating batteries. When discharging at the normal rate, the discharge should never be allowed to fall below a voltage of 1.75 volts per cell. At rapid rates the discharge may be carried down to 1.60 volts per cell. If the discharge be continued after these voltages are reached, the plates may be permanently injured.

The rate of charge may be rapid when the battery is nearly or quite exhausted, but should be low when nearing the end of the charge, that is, after gassing begins. The maximum charging rate should not be greater than the two-hour rate, when the eight-hour rate is normal. Thin plates allow a more rapid charge than thick.

Each of the cells of a battery should be tested with a voltmeter and a hydrometer once a week. Where the number of cells in a battery is large, frequent inspection of each cell is impracticable. Therefore, a cell which receives the same usage as the rest is selected to serve as an indicator, and is known as a "pilot cell." Daily readings of the voltmeter, hydrometer and thermometer should be taken from this cell.

Unless a battery is properly looked after, sulphation of the injurious kind is liable to set in with the resulting shedding of active material, buckling, loss of capacity, increase of internal resistance with consequent reduction of efficiency, and increase of temperature with passage of current.

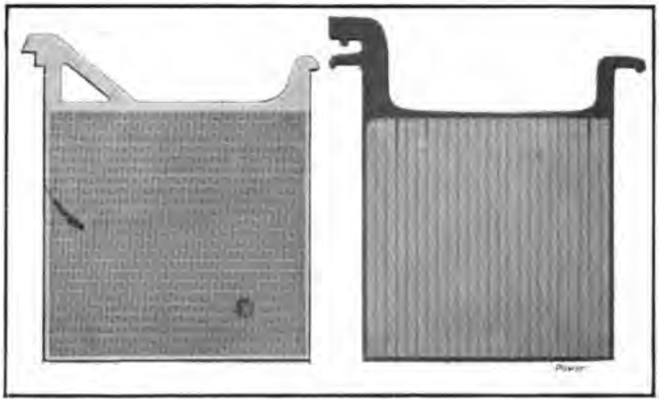


Fig. 4.

"Tudor" positive and negative (pasted) plates—Electric Storage Battery Co.

EFFICIENCY

The efficiency varies with the rate of charge and discharge. The shorter the cycle of charge and discharge, the higher is the efficiency. Under usual conditions, the watt-hour efficiency of a battery used for storage only, that is, fully charged and subsequently fully discharged, is from 70 to 80 per cent. The larger the battery, and the higher the voltage at the end of discharge, the greater will be the efficiency. With large batteries, in which the charge is never continued very long after gassing begins and discharge is stopped at about 1.87 volts, the efficiency of storage cells may be as high as 85 per cent. A fair commercial figure is 80 per cent for storage and 92 per cent for regulation batteries.

CAPACITY

The term "capacity" is to be understood as referring to the amount of energy in ampere-hours which may be taken out of a cell from the beginning of discharge until the voltage has decreased to 1.80 volts, when the battery

[illegible]

[illegible]

[illegible]

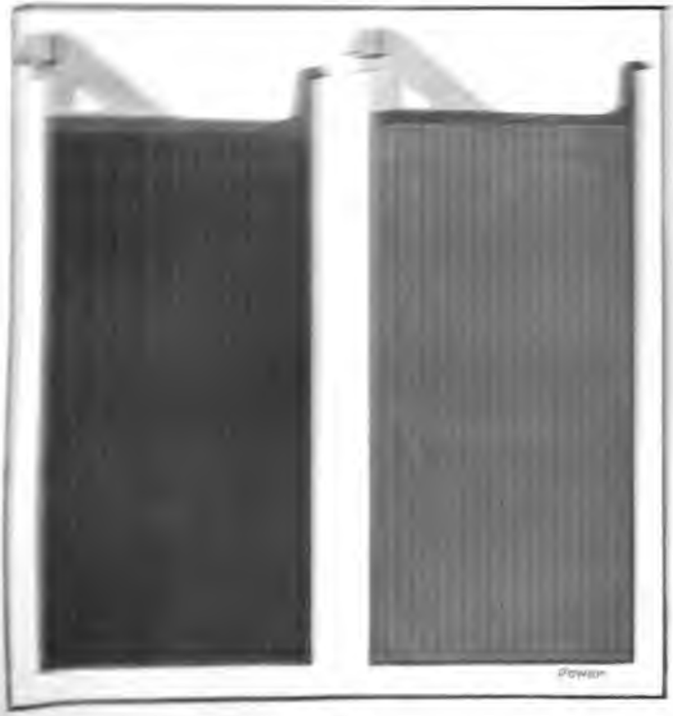


FIG. 5.

Positive and negative "Exide" plates—Electric Storage Battery Co.

[illegible] into the cell, and lack of correct attention have a marked detrimental effect. The life of a pasted plate is shorter than that of the Planté type while the life of a negative plate of either kind is from two to five times that of a positive plate of the same kind. Planté positive plates have a total [illegible] 1900 discharges at the eight-hour rate.

EDISON TYPE

[illegible] idea of Edison's work appears to have been the elimination of [illegible] and the substitution of a mechanically strong material for lead. The first result of his efforts was an alkaline-cadmium-copper oxide cell, which was withdrawn from the market in 1901. After six more years of persistent investigation, he brought out the present nickel-iron-alkaline cell.

PLATES

The positive plate consists of heavily nickel-plated, perforated steel tubes, arranged in rows and filled with alternate layers of nickel hydroxide and exceedingly thin flakes of pure nickel. The materials are fed in such quantities as to make layers approximatley 0.01 in. in thickness for the nickel hydrate and less for the nickel flake. The tube, after being filled with active material, is reinforced with seamless steel rings, which prevent it from expanding away from and breaking contact with the contents. The tubes, after being crimped and flattened at both ends, are clamped into perfect contact with a steel frame or grid, made of cold-rolled steel and heavily nickel-plated.

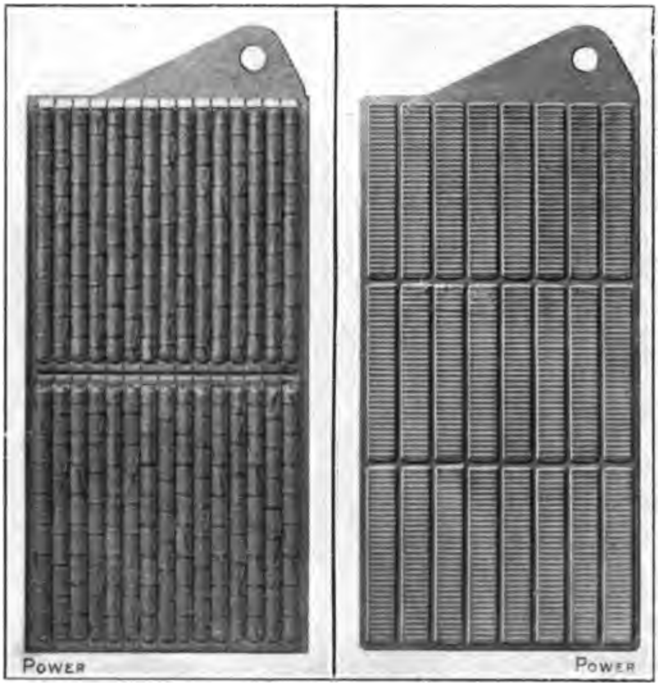


FIG. 6.

Positive and negative plates—Edison battery

The negative plate consists of a grid of nickel-plated, cold-rolled steel, holding a number of rectangular pockets filled with powdered iron oxide.

The perforated container construction prevents loss of active material by disintegration, thus doing away with sediment, internal short-circuits, and the necessity of cell washing. Moreover, the steel-nickel construction of the plates makes "buckling" impossible; even a dead short-circuit of the terminals will not affect the condition of the plates. The materials composing the plates are immune from attack by the electrolyte and thus their permanency is assured.

SEPARATION AND INSULATION

The plates are separated by narrow strips of specially treated hard rubber. These strips correspond to the wood and rubber separators used in lead batteries, but unlike them are not injured by the electrolyte and need never be renewed. The end insulator is provided with grooves that take the edges of the plates, spacing them and insulating them from the steel container. At the sides of the cell, between the outside negative plates and the container, are inserted smooth sheets of hard rubber. At the bottom, the elements rest upon a hard-rubber rack or bridge, insulating the plate from the bottom of the container. The plates of the positive and negative groups

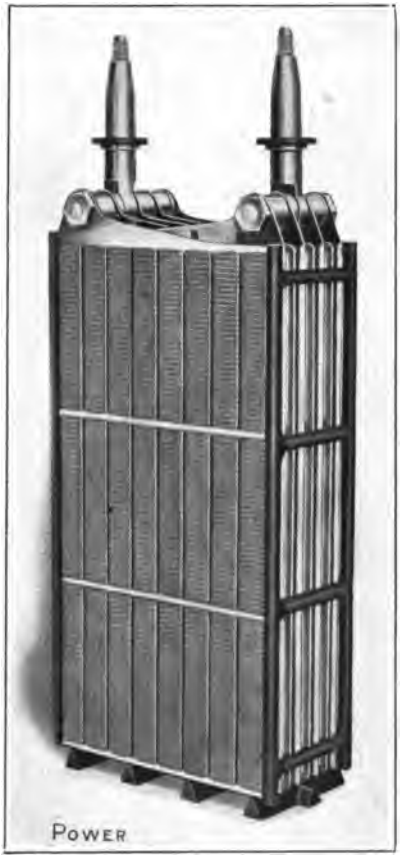


Fig. 7.

Assembled plates of Edison battery removed from container are respectively fastened by nuts to horizontal steel rods integral with the positive and negative terminal pieces and distanced by steel washers.

ELECTROLYTE

The electrolyte consists of a 21 per cent solution of potassium hydroxide in distilled water, with a small percentage of lithium hydroxide, having a normal specific gravity of about 1.200. The lithium hydroxide seems to accomplish a cementation of the positive material. In the early type where caustic potash was used alone, the positive plates deteriorated very rapidly, but when the action of the lithium hydroxide was discovered and applied, this deterioration was overcome. The electrolyte does not vary in density during charge and discharge, nor is the capacity of the battery affected materially by slight variations. In mixing the electrolyte, no special care need be exercised in order to prevent injury to the operator, and the potash solution does not attack the steel.

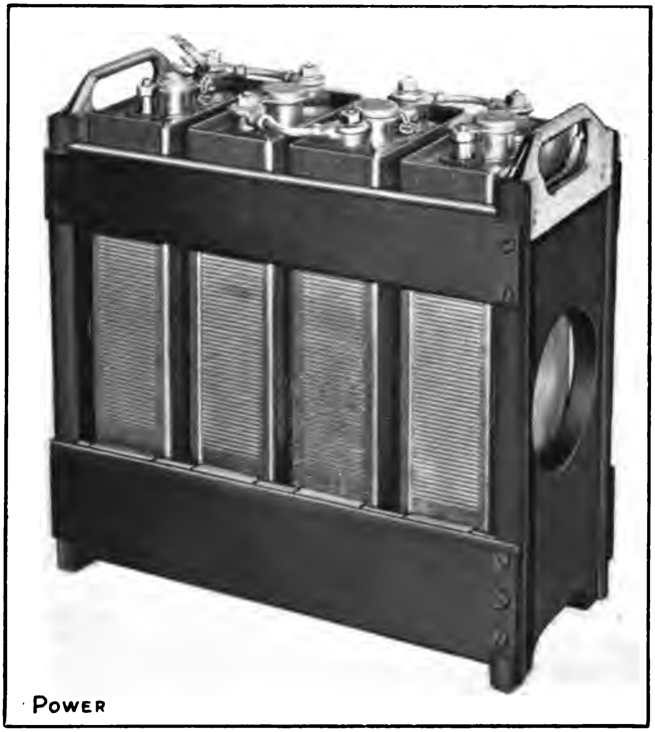


FIG. 8.

Assembled cells in battery tray—Edison type

CONTAINING CELL

The rectangular container is made from cold-rolled, corrugated, nickel-plated sheet steel, welded at the seams by the autogenous method, making leakage or breakage from severe vibration impossible. The nickel protection is supplemented by dipping the container in a compound which gives it a tough, yet flexible insulating coating. The cover or top is nickeled steel and is welded to the rest of the can after all parts have been assembled therein.

The cover of the early type of can had four mountings. Two of these openings were for the polepieces, a third for the separator valve, which permits the escape of gas when charging, but prevents spraying, evaporation, the spilling of the electrolyte and the entrance of impurities. The fourth opening was for the purpose of adding water to replace that carried off in charging, and was fitted with a cover that could be clamped down and made water-tight by a locking lever. The present form of cell has the separator valve inside of the filling aperature, so that there are only three perforations in the can cover.

ASSEMBLING AND MOUNTING

The cells are assembled into a battery in strong side-suspension trays, the cells rest upon and are held firmly in place by means of steel supports known as "cradles" and "hold-downs." The weight of an Edison battery being about half that of a lead battery of the same capacity, and the former occupying a slightly smaller space, a lighter construction can be used in a battery room for the former than the latter. The Edison battery requires no fan-ventilated isolated room as no corrosive fumes are generated. The life of the containers depends upon their state of cleanliness, and if neglected they will corrode sooner or later.

The cells are electrically connected by nickel-plated copper links, swedged into lugs, which fit the tapered steel cell terminals. The lugs are drawn down and held to a tight fit by means of nickeled steel nuts, which screw on the ends of the terminals. To facilitate disconnecting, a screw jack is used to separate the lugs from the taper terminals to which they practically "freeze." Any person can connect up the cells and no skilled laborer, such as a "lead burner," is needed.

CARE AND MANAGEMENT

The care required by the Edison cell is limited to such matters as the addition of distilled water to make up for charging loss, the renewal of the electrolyte when its specific gravity is below 1.16 after a full charge, the keeping of the outside of the battery clean, and the occasional recoating of the trays with an alkali-proof paint.

It is permissible, for short periods, to discharge at any rate desired; but maximum power is developed when the current is about six times normal. Continuous discharge should not exceed 25 per cent above normal rate. Short-circuits subject the cell to severe strains, but no injury results if the short-circuits are not consecutive and often repeated.

The ability of the Edison cell to stand short-circuits is due to its high internal resistance. The short-circuit current for the alkaline type of battery is about sixteen times its normal discharge current, while that for the acid-lead type is about fifty times its normal discharge current.

Charging should never be done at less than the normal seven-hour rate, and may be boosted to high rates for brief periods so long as the temperature of the cell does not rise above 115 deg. The Edison cell can be recharged at any time, without injury, regardless of the extent of the former charge remaining. Moreover, no damage is done by long and oft-repeated over-charging. The only thing necessary when taking a cell out of commission is to fill the cell with distilled water to ½ in. above the plates. When putting the battery in commission, the plates should be covered with electrolyte and the cell charged for 12 hrs. at normal rate, after which the cell may be treated as usual. Cells have had their electrolyte boiled away and have stood empty for weeks without being injured. They regained their full capacity after being charged and discharged once. The effect of charging in a reversed direction for 15 hrs. at the eight-hour rate was remedied after having subjected the cell to four cycles of charging and discharging in the normal direction.

EFFICIENCY

The efficiency of the Edison battery is lower than that of the lead cell and is necessarily so on account of the low electromotive force, about two-thirds that of the lead battery. The efficiency is much increased by partial charging as compared with normal charging. On short charges the efficiency is 95 per cent for ampere-hours and 75 per cent for watt-hours, while on seven-hour charges this falls to 82 per cent for ampere-hours and 58 per cent for watt-hours. The volt efficiency is about 72 per cent for the usual charge. The efficiency of the Edison cell in contrast to that of the lead cell increases with use.

CAPACITY

The capacity of an Edison cell increases with use and it is guaranteed to give its full capacity for four years. The capacity of the cell varies from 13.5 to 17 watt-hours per pound of material and from 0.65 to 0.75 watt-hours per cubic inch of complete cell volume.

LIFE

Owing to the comparatively recent development of the Edison cell its ultimate life is not known definitely. Batteries, which are being tested for life under purposely imposed conditions designed to shorten their life, have developed over 1200 complete cycles of charge and discharge, and still show a capacity about 10 per cent above their normal rating. The life of a cell is shortened by continuous working at high temperatures and high current rates, but the occasional subjection to these treatments is said to have no detrimental effect.

COST

The first cost of an Edison cell is more than that of a lead cell of equa- capacity; the list price of a complete single cell being from 6 to 9c. per ampere-hour of capacity. When durability and small maintenance cost are considered, however, this difference is compensated.

CONCLUSIONS

The relative advantages and disadvantages of the two types of cell may be summarized as follows:

(1) The principal advantage of the lead cell lies in its high efficiency and low first cost.

(2) Among the innate disadvantages of the sulphuric-acid battery can be mentioned: Excessive weight; structural weakness of parts; corrosive nature of electrolyte and fumes; loss of capacity; shedding of active material;

exacting and incessant care required for successful operation; fracture and buckling of plates; sulphation; internal discharge; high installation and maintenance costs.

(3) The advantages of the Edison cell are: Increase of capacity with use; simplicity of the care required; ease of interconnecting the cells; steel-preserving electrolyte and lack of corrosive fumes; durability and sturdiness of cell structure; low weight per unit of capacity; ability to withstand short-circuits; absence of sulphation, buckling and sediment; immunity from injurious effects of overcharge; low maintenance cost.

(4) The disadvantages of the Edison cell may be summed up as high initial cost and comparatively low efficiency, due to low cell voltage.

It is thus evident that each type of battery has its special field, and, hence, a satisfactory selection can be made only after an exhaustive investigation of all the factors entering into an installation.—*Power.*

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NOTE ON THE CORRECTION FOR WIND

By P. CHARBONNIER, Chief Engineer of Naval Artillery (France)

1. The well known theory by which is calculated the effect of wind upon the trajectory of a given projectile is assumed.

If, of a wind blowing horizontally, we designate by w_1 and w_2 the components in the plane of departure and in a plane at right angles thereto (under the supposition that the two components are small in comparison with the horizontal velocity u of the projectile, which renders it permissible to consider separately the effect of the two components), we have the formulas

$$\frac{(\Delta X)_w}{X} = \frac{w_1}{u_0} C_w (u_0, u_\omega)$$

$$Z = w_2\left(T - \frac{X}{u_0}\right)$$

for the change (ΔX) in the range X and the lateral deviation Z. Moreover, in direct fire, the secondary function C_w is known; so that, in the case of resistance of the air expressed by the monomial $F(v) = B_n v^n$, we have

$$(\Delta X)_w = w_1 \left[T - \frac{X}{u_0} + (n-1)\left(1 + \frac{\tan \alpha}{\tan \omega}\right)\frac{X}{u_0}\right]^*$$

The method of deducing these formulas is well known, whether by General Didion's theory, which regards the relative motion of the projectile, or by direct investigation, the corrective forces due to the action of the wind being introduced.

2. Concerning the foregoing formulas it is some times asked why they take no account of the form of projectile. In particular, it appears singular that in the expression for the deviation Z there is not introduced, in one form or another, a term representing the lateral surface of the projectile, a surface which, it would seem, must nevertheless affect the phenomena. No distinction is made between a long projectile and a short one, while to common sense it is obvious that the action of the wind on the two must differ.

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* See *Blaistique exterieure rationnelle. Problemes balistiques secondaries.* E. S., Paris, Doin, 1907, p. 73.

That the usual formulas do not take into account the form of projectile is not surprising, when it is remembered that they are deduced from the theories of *Balistique du point matériel* (ballistics of the material point), which reduces all projectiles to their center of gravity by transferring to that point (and parallel to their true directions) all forces concerned.

But it is, however, very easy to deduce formulas which are in conformity with *Balistique du solide invariable* (ballistics of a rigid body); such is the object of this note.

LATERAL DEVIATION

3. We must introduce the action of an oblique resistance. Let us take a projectile moving horizontally with the velocity u (we are here concerned with direct fire). Perpendicular to its trajectory (Fig. 1) is blowing a wind w_2, very small in comparison with u.

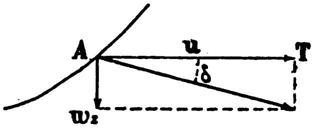

FIG. 1. 1397

The action of the air on a point A of the lateral surface of the projectile is equivalent to that due to a velocity,

$$u' = \sqrt{u^2 + w_2^2} = u\left[1 + \frac{1}{2}\left(\frac{w_2}{u}\right)^2\right]$$

which makes with the direction of motion, AT, an angle

$$\delta = \frac{w_2}{u}$$

Now, the problem of finding the components of a resistance $cF(u')$ making an angle δ with the direction of motion is a common one, which serves, for instance, as the basis of numerical application of the theory of drift.

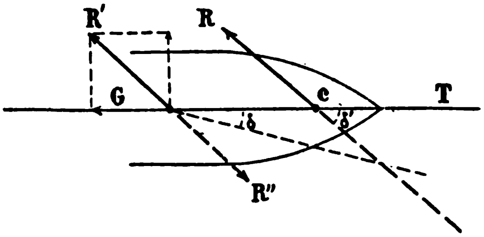

FIG. 2. 1398

We know, indeed, that, for small angles δ, the resistance of the air passes through a point C (Fig. 2) called the *center of resistance;* and that it makes with the direction of motion, GT, an angle δ', different from δ, and such that it may be represented by the formula,

$$\delta' = k\delta$$

in which k is a constant, characteristic of the form of projectile for oblique resistance.

Let us cause the center of gravity G to be acted upon by two equal and opposed forces R′ and R″, parallel to the force R applied at C (Fig. 2).

The force R′ will affect the motion of the center of gravity. The couple, R″ GCR, will tend to cause the projectile to turn. Its action is identical with that of the oblique resistance applied at the same point C and due to the motion of rotation of the projectile combined with the progressive depression of the tangent to the trajectory. Then this couple will generate a *precession* the velocity of which is exactly the same as that of the precession ordinarily considered in the theory of drift.

There remains the action of the force R′ upon the center of gravity, and it will be resolved into two components:

(1) One is R′ cos δ' along GT.

$$R' \cos \delta' = -\ cF\ (u)$$

$$R' = -\ cF\ (u'')$$

where,

$$u'' = u\left(1 + \frac{1}{2}\delta'^2 \ldots\right) = u'\left(1 = \frac{1}{2}\delta^2 + \frac{1}{2}\delta'^2 \cdots\right)$$

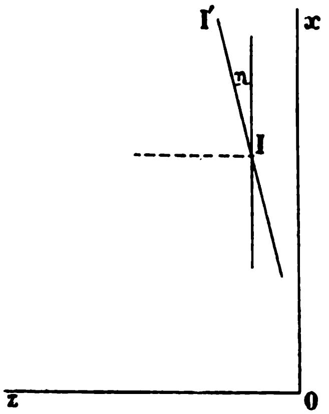

Fig. 3.

Neglecting all terms in this expression except unity, we have

$$R' = -\ cF(u')$$

where

$$u' = u\left[1 + \frac{1}{2}\left(\frac{w}{u}\right)^2 \cdots\right]$$

Whence, neglecting all terms except unity, we have,

$$R' = -cF(u)$$

(2) The other is R′ sin δ', at right angles to the trajectory, the expression for which is

$$\delta' cF(u) = k\frac{w_2}{u} c\ F\ (u)$$

Therefore, a cross wind w_2 does not appreciably affect the vertical projection of the trajectory. It gives rise, at right angles to the plane of departure, to a force of which the acceleration is:

$$E_z = k \frac{w_2}{u} c\,F\,(u)$$

4. Let O, Fig. 3, be the origin, Ox the trace of the plane of projection, Oz a horizontal axis. The projectile, under the influence of the disturbing acceleration E_z, which is very small, departs very slightly from the plane of departure and, when it shall have arrived at I, the tangent, II′, to the trajectory which it describes will make with the axis Ox a very small angle η.

The acceleration of the resistance of the air $cF(u)$ has as components $-cF(u)$, in the direction of the axis x, and $-\eta cF(u)$, in the direction of the axis z. We shall have, then, as the equation of the horizontal motion:

$$\frac{d^2z}{dt^2} = -\eta\, cF + E_z$$

But, by definition,

$$dz = \eta dx$$

whence, by differentiation,

$$\frac{d^2z}{dt^2} = \eta \frac{d^2x}{dt^2} + \frac{d\eta}{dt}\frac{dx}{dt}$$

which, substituting $-$ cF for $\frac{d^2x}{dt^2}$, will become,

$$\frac{d^2z}{dt^2} = -\eta\, cF + \frac{d\eta}{dt}\frac{dx}{dt}$$

We then have, combining the two expressions for $\frac{d^2z}{dt^2}$, the formula:

$$\frac{d\eta}{dt}\frac{dx}{dt} = E_z$$

Now, since $u = \frac{dx}{dt}$, it will become

$$d\eta = E_z \frac{dt}{u}$$

Then integrating once we derive, for the value of the inclination η, the formula:

$$\eta = \int_0^t E_z \frac{dt}{u}$$

Since $dz = \eta dx$, we may write, after a second integration:

$$z = \int_0^x dx \int_0^t E_z \frac{dt}{u}$$

That is the equation of the horizontal projection of the trajectory, due to any disturbing acceleration whatever, E_z.

5. Let us take as an example a cross wind w_2 which causes a lateral acceleration:

$$E_z = k \frac{w_2}{u} c\,F$$

We shall have:

$$\eta = kw_2 \int_0^t \frac{cF}{u^2}\, dt$$

But in direct fire we have:

$$dt = -\frac{du}{cF}$$

Hence,

$$\eta = -kw \int_{u_0}^{u} \frac{du}{u^2} = -kw_2 \left(\frac{1}{u_0} - \frac{1}{u}\right)$$

On the other hand:

$$dz = \eta dx = -kw_2 \left(\frac{dx}{u_0} - \frac{dx}{u}\right)$$

But,

$$dx = udt$$

therefore,

$$dz = -kw_2 \left(\frac{dx}{u_0} - dt\right)$$

that is to say:

$$z = kw_2 \left(t - \frac{x}{u_0}\right)$$

which is the formula we desired; and it differs from the usual formula only in the presence of the factor k of oblique resistance.

EFFECT ON RANGE

6. Let us now investigate (still considering direct fire) the action of a head wind w_1 in the plane of departure. Let us proceed as before (Fig. 4).

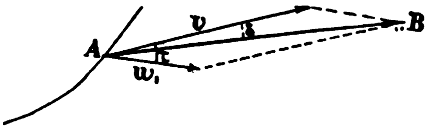

FIG. 4. 1400

The resultant of the forces v and w_1 at the point A is along AB, and we have:

$$\overline{AB}^2 = v^2 + w_1^2 + 2vw_1 \cos \tau$$

Or, in the case of direct fire:

$$AB = u + w_1$$

But the angle δ is such that

$$\frac{w_1}{\delta} = \frac{u + w_1}{\tan \tau}$$

hence,

$$\delta = \frac{w_1}{u + w_1} \tan \tau = \frac{w_1}{u} \tan \tau$$

If we combine (Fig. 5) all resistances due to forces such as AB acting upon the different points of the surface of the projectile, they give a resultant $cF(u+w_1)$ applied at the center of resistance C, and making with the tangent to the trajectory an angle δ' such that:

$$\delta' = k\delta = \frac{kw_1}{u}\tan\tau$$

This force will give rise to a couple which will influence the motion of the projectile about its center of gravity, but will still cause a precession having the same velocity as that due to drift.

But the force $cF(u+w_1)$, transferred to the center of gravity G, will be resolved into two others:

(1) $R'\cos(\tau-\delta')$, in the horizontal direction, which may be reduced for direct fire to:

$$-R' = cF(u+w_1)$$

(2) $R'\sin(\tau-\delta')$, in the vertical direction.

But,

$$\sin(\tau-\delta') = \tan\tau-\delta' = \left(1-\frac{kw_1}{u}\right)\tan\tau$$

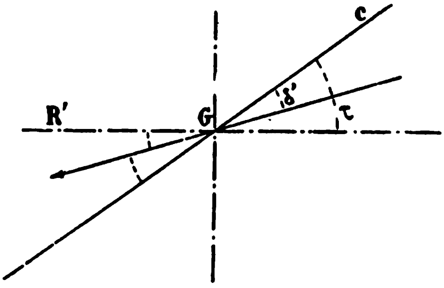

FIG. 5.

1401

The vertical component is, therefore:

$$-cF(u+w_1)\left(1-\frac{kw_1}{w}\right)\tan\tau$$

The differential equations for the motion of the projectile are, therefore:

$$\frac{d^2x}{dt^2} = -\,cF(u+w_1)$$

$$\frac{d^2y}{dt^2} = -\,cF(u+w_1)\left(1-k\frac{w_1}{u}\right)\tan\tau-g$$

If, in this system of differential equations, we make $k=1$, we get the trajectory in air in motion of the usual theory, which requires, relatively to the trajectory in air at rest, a correction,

$$\frac{(\Delta X)_w}{X} = \frac{w_1}{u_0}C(u_0, u_w)$$

It follows from this that, since we may write

$$\frac{d^2y}{dt^2} = -\,cF(u+w_1)\left(1-\frac{w_1}{u}\right)\tan\tau-g+(k-1)cF(u+w)_1\frac{w_1}{u}\tan\tau$$

the effect of the form of projectile may be provided for by the introduction of a corrective force the expression for which is:

$$E_y = (k-1)\frac{w_1}{u} cF(u) \tan \tau$$

It will be sufficient to calculate the effect on the range caused by that corrective force, and then to add it to the usual correction. In that way the complete solution of the problem may be had.

It will be observed at once that the effect of E_y will be very small, because of the factor tan τ, which is small in direct fire and changes its sign at the summit.

7. As for the calculation of $(\Delta X)_1$, a correction complementary to the usual correction $(\Delta X)_w$, it presents no difficulty. We have given elsewhere* the general calculation of the range corrections for any disturbing accelerations, E_x and E_y.

If $E_x = 0$, we have:

$$(\Delta X)_1 = -\frac{1}{c^2 \tan \omega} \cdot \int_{u_0}^{u} \frac{udu}{F} \int_{u_0}^{u} E_y \frac{du}{uF}$$

a formula which here becomes:

$$(\Delta X)_1 = -\frac{(k-1)w_1}{c \tan \omega} \int_{u_0}^{u} \frac{udu}{F} \int_{u_0}^{u} \tan \tau \frac{du}{u^2}$$

We shall substitute for tan τ, $q - \frac{J(u)}{c}$, in which $q = \tan \alpha + \frac{J_0}{c}$

and we shall have, by the introduction of some ballistic functions, the solution of the problem.

It does not appear useful to introduce that calculation here.

CONCLUSIONS

8. The influence of the form of projectile is provided for, in air in motion, by introducing in the formulas the *coefficient of oblique resistance k.* A couple results which, applied at the center of resistance, causes a movement of precession, the velocity of which is the same as that of the movement of precession considered in the usual theory of drift.

9. A cross wind of velocity w_2 causes a lateral deviation equal to that given by the usual theory multiplied by the factor k. This factor, which depends upon the form of the ogive, has, in the case of the not very pointed projectiles now is use, values of 2 and 3. If we consider very pointed ogives this number increases considerably and can be as large as from 7 to 10. The long pointed projectile will, therefore, be very sensitive to a cross wind, and the changes in the velocity of the wind from shot to shot will tend to make the firing irregular in direction.

10. A wind w_1 blowing horizontally in the plane of departure causes a change in range which can be, as a rule, calculated by the usual formulæ. The effect of the form of projectile represented by the factor of oblique resistance, k, enters, indeed, only in a correcting term which is very small relatively to the value calculated by the usual method. The influence of the form [for wind correction] is, then, much less in range than in deflection; and that is easily conceivable, in direct fire at least, where the projectile moves with its axis almost horizontal.—*Revue d'Artillerie.*

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* *Journal de l'Ecole polytechnique* (1908). *Etude de l'influence de la rotation de la terre sur le mouvement des projectiles dans l'air*, p. 94-97.

CAPS FOR ARMOR-PIERCING PROJECTILES*

When an armor-piercing projectile fitted with a cap of any of the kinds now commonly used strikes obliquely against a hard-faced armor plate, the metal of the cap which lies on that side of the point of the projectile which forms an acute angle with the plate has to be displaced in a radial direction more rapidly than the metal of the cap which lies on the side which forms an obtuse angle with the plate, with the result that the lateral or radial pressure exerted by the cap upon the pointed end portion of the projectile due to the inertia of the mass of cap metal is considerably increased on the side nearest to the plate, that is to say on the side forming an acute angle with the plate, as compared with that on the other side of the projectile, the side forming an obtuse angle with the plate, thus causing an unbalanced lateral or transverse stress on the pointed end portion of the projectile in addition to the stress exerted thereon when the point of the projectile reaches the plate, with the result that the projectile seldom or never completely

Fig. 1

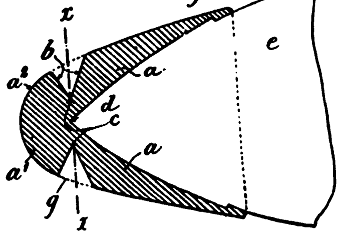


Fig 2.

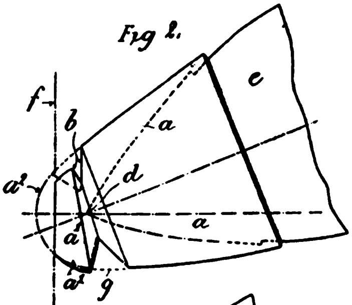
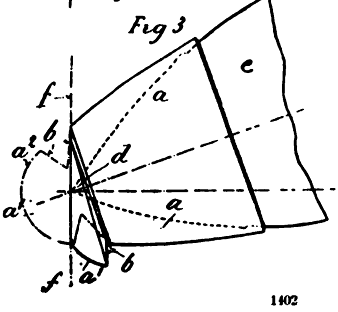


Fig 3



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* British Patent No. 21903, October 1st, 1913, by Sir R. A. Hadfield, F. R. S., A. M. Jack, and Major A. B. H. Clerke.

perforates the plate without being itself broken up, except at comparatively high velocities. This invention has for object to provide caps adapted to afford a more uniform and effective support to the pointed end portion of a projectile than hitherto when striking a hard-faced armor plate obliquely, so that the projectile may completely perforate the plate without becoming broken up, even when traveling at a comparatively low velocity. Fig. 1 shows in longitudinal section a solid cap applied to the pointed ogival end portion of an armor-piercing shell which is shown in elevation. Figs. 2 and 3 are similar views showing two stages of how the forward end portion of the cap is thrown over or displaced on striking an armor plate obliquely. The cap *a*, which externally is mainly of ogival shape with a solid forward end portion a^1 having a rounded or convex front surface a^2, has formed therein an annular groove *b* of vee shape the inner end or bottom of which surrounds a solid portion *c* of the cap metal of reduced cross sectional area located in a plane *x x* transverse to the axis of the cap which plane passes through or closely adjacent to the point *d* of the projectile *e*. Figs. 2 and 3 show approximately how the head portion a^1 of the cap on striking an armor plate, indicated at *f*, obliquely, is displaced to that side of the pointed end portion of the projectile *e* that forms an obtuse angle with the plate. The groove *b* may be covered by sheet material, as indicated by dotted lines at *g* (Fig. 1) to present a continuous surface to the air during flight. Or the cap may, if desired, be surmounted by a hollow air deflector of known construction. Such a cap will enclose the solid forward end portion a^1 of the cap and be secured to the body or rear portion *b* of the cap.

—*The Broad Arrow.*

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THE DOUBLE REPORT OF PROJECTILES

Referring to the cracking sound, or sound of a double report, noticeable when a high velocity projectile passes, Lieutenant G. W. Edgerly, 5th U. S. Infantry, writing to the Scientific American, says:

"This sound, which may seem louder than the report of the piece if the latter is fired from a distance, is only noted in projectiles of a greater velocity than 1100 foot-seconds, which is about that of sound waves, and is caused by the bullet passing through the atmosphere. As its velocity is equal to or greater than that of sound, its arrival at a point opposite the hearer precedes that of the sound waves it set up at an earlier stage of its flight, and the sharp crack the bullet makes is caused at that part of its flight opposite to or nearest the hearer. As it recedes from the hearer, the sound waves apparently follow it away from the hearer, and do not come strongly back to him, and they are drowned out by the relatively more intense sound made by the projectile at the instant it passed him. If, however, the person noting this phenomenon is at some distance from the line of flight of the projectile, he hears the sound made by the projectile over a considerable part of its course blending with and following the sharp report it makes as it passes him, and if his position is sufficiently distant, the report of the projectile so blends with this whizzing or roaring sound as to be nearly lost in it. In the case of a small bullet, the sound much resembles the tearing sound made in tearing stiff, strong cloth, and in case of a large projectile it sounds much like a train in a tunnel or covered bridge. It follows that unless one is very distant from its course, he cannot hear such a swift-moving projectile until it has passed him; therefore, the bullet he hears can never strike him. A small bullet is not often heard after being fired by one standing near the firer, as the rifle report drowns the sound it makes for a long enough time to permit it to travel beyond hearing distance, but this is not true of cannon projectiles, which make a much louder sound, audible farther away. Modern high-velocity bullets do not "whistle" until they take up a ricochet flight, after grazing some object, unless they tumble, or otherwise fail to fly true. Under the latter conditions they emit the weirdest sounds imaginable, in great variety. This is due to their low velocity, often distorted shape, and erratic flight."

—*Scientific American.*

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LANDING OF TROOPS

In disembarking troops from transports, the great danger is the landing.

Either we consider the landing of companies from a squadron to make raid, cut a railroad line, wreck a tunnel, and even to engage in warfare in colonial land, and re-embark afterwards; or else we contemplate landing a real army corps, to operate a division on a large scale.

Although landing companies have but a limited importance, the French Navy has just reorganized them, when adopting the *mitrailleusses.* Hereafter all battleships, or cruisers of at least 8000 tons, will be able to disembark a landing company including three sections of infantry (which will be supplied with material of destination) and one section of *mitrailieusses* (machine guns).

In addition to this, when two companies are to operate together, they will be supplied with a section of 65 mm. guns.

The other operation, carried on on a large scale, is apt to succeed in uncivilized countries with sparsely settled populations. But elsewhere, wireless telegraphy, flotillas, continential armies, render it more and more difficult, it being more a bugbear than a real danger.

Nevertheless, the grand maneuvers of 1912 of the English Navy have exposed to light the fact that hazard has a great influence upon operation. Fog is one of the causes to be mentioned in this circumstance. Thanks to the prevalence of thick weather, a small squadron having for mission the landing of troops on the English coast, is able to occupy a roadstead for some hours without being disturbed. Now, in an emergency, a few hours would be sufficient to land an important expeditionary corps, especially if the invader has taken the precaution to obstruct the passes with mines.

In any case, an operation of that kind demands careful preparation embracing the minutest details.

In the olden times, landings were comparatively easy; the invaded party was not provided with means of rapid communication, nor small units capable of attacking the transports. Several instances may be quoted, "All of them without any risk to the assailer." The expedition of Algiers (1830); Crimea, 1854; the China expedition, 1860; Egypt, 1882, when the English landed 14,000 men and 3800 horses; the English exedition of the Transvaal, 420,000 men; the Japanese, in Manchuria, landed 500,000 to 600,000 men. In this case the difficulties were almost nil, the armies of the Mikado having but an arm of the sea to cross over in order to reach the field of hostilities. To the west of the passage of the transports, Togo blockaded the Russian Squadron in Port Arthur in order to keep open the Japan-Corea line of communication.

This is a striking example of the support of an army by a fleet, and the type of what is called "a combined operation." Finally, we must mention the landings of the Italians upon various points of the North African Coasts and the Aegean Islands and all under the most favorable circumstances, the Turkish squadron being moored in the Sea of Marmora, and the landings taking place on deserted shores.

After pointing out the landing operations of the allies in the Crimea, we will choose as examples the extensive littoral of the British Islands and that of Italy, a vast peninsula attached to the Continent by the imposing mass of the Alps, but presenting a very valuable extension of coasts.

In 1854, the allies resolved to carry the war into Crimea in order to strike at the heart of the Russian colossus, by wresting from it Sebastopol, its only arsenal at that time, in the Black Sea.

Both French and British started out somewhat improvidently. The idea was to assail the enemy in his own country, without reliable maps of the latter, with only vague notions concerning the adversary, his effective forces, resources and armaments.

By the admission of General Bosquet, the fleet, already almost paralyzed through scarcity of coal, was lacking in the means of landing the expeditionary corps. First problem to be solved was, where to land? The English advised the shore of "Old Fort" south of Eupatosia.

The landing of the personnel was carried out regularly, but the material! "Everything comes up in separate and broken pieces," wrote Marshal St. Armand: "Guns without their mounts and horses, horses without their guns and caissons. I have 42 guns drawn by horses instead of 100, and one thousand odd horses." Nevertheless, the landing was made without any fear of opposition, and shortly afterwards the allies routed at Alma the Russian Army commanded by Prince Menschikoff. It is true that at that time there were neither railways nor torpedo boats, submarines nor wireless telegraphy.

England, it is said, suffered fifty-four invasions between 1066 and 1798. But nowadays, the invasion of that country, which would mark the end of the British Empire, is next to an impossibility. Her statesmen have, however, studied that eventuality. Mr Balfour reckoned that in order to transport 70,000 men, it would require a tonnage of from 200,000 to 250,000 tons. Reckoning in that way, the transportation of 200,000 soldiers mentioned by Lord Roberts, would require 85 ocean liners, that is, a line 50 kilometers long in single file with distances of 400 meters; of course a more closed order might be adopted, but, in whatever shape, it would present an immense target. And in the case of the convoy dividing in small groups, the chances of an encounter with the adversary would be multiplied.

It was in regard to Germany that the British Government examined that possibility. The nearest point to the coast of England is about 370 miles from Germany, about 18 hours steaming at 20 knots. But doubtless the convoy, as we will see later on, would undertake a longer route, and would be more than 18 hours at sea. It is possible to imagine the massed steamers leaving the Elba and Weser at night and taking their course northward to reach a point selected in advance on the Scottish coast. To the south, the German Fleet would constitute a screen. That squadron would oppose a desperate resistance. In the opinion of general Broussart Von Schellendorf, "the fact of obtaining for one moment the command of the sea and opening the way to our transports would justify the sacrifice of the entire fleet."

When considering a "combined operation" one is led to calculate only the time required to reach the spot; in this case, the crossing of the North Sea. This is not speaking seriously. One must also ask oneself this question of prime importance from the point of war, of the possible surprises: How many hours will the landing take? Although rapidity is indispensable, the question, however, does not consist in landing in the quickest possible time the personnel and the impedimenta (brought down to the strictest minimum) in a hostile country in order not to perform a military promenade, but to fight a population which will defend their homes with desperation.

To put on shore both personnel and material under the most satisfactory conditions is the problem, and its solution does not appear easy.

The great draft of water of the transports, combined with the exigencies of the tides, will force the convoys to keep off shore and use lighters for landing operations. It can thus be seen that many lucky circumstances combined are necessary to successfully land an expeditionary corps, and the fact that one is not master of the sea but adds to the temerity of the enterprise.

So far we have only spoken of the assailants. but what of the defenders?

Great Britain has semaphores along its coasts, wireless stations, railways, destroyers, and submarine flotillas. The odds are that the convoy will enter the line of vision of a signal station. Then all the means of defense that have remained intact, even after a naval disaster (very unlikely), land troops, ships of the second line of defense, mine layers, destroyers, will converge towards the point of the littoral threatened, in order to destroy the invader. To attempt a landing in those conditions is to challenge destruction.

In Italy, the prevailing ideas touching the defense have greatly altered since 1870. It was at first proclaimed that the frontiers of the Alps were the core of the peninsula's defense, hence the erection of forts on the heights and the formation of the Alpine troops by general Ricotti. After stopping the holes in the Alps, it was foreseen that nothing could prevent a victorous squadron from landing an army upon the coasts, which present many favorable landing points.

Between 1882 and 1889, the Italian Government spent 130 million francs in the defenses of the western and northwestern coasts, and the system is far from being complete.

From Ventimiglia (French frontier) to Civita-Vecchia, a railway with a single track, nearly everywhere situated at a short distance from the sea, can be easily cut by the enemy. This is a very serious contingency, for on a part of the line repairs would simply be impossible, owing to lack of time and because of the enormous costs; between Genoa and Spezzia there are 80 tunnels hewn out of the rock.

On the other hand, the adversary can make use of several anchorage grounds on that part of the coast, in order to operate a landing. In the south, we notice some anomalies: Naples has an unprotected navy yard, and, by its side, Gaeta has fortifications but no navy yard.

General Ricci reckoned at 60,000 the number of men an adversary could land on the Italian coasts. Later on, another party exaggerating, as frequently happens in that country, raised that number to 300,000, but those who thus spoke had no idea of the "impedimenta" already mentioned in regard to Great Britain. There were also some who considered coast fortifications as of no account. "It would," they said, "be necessary to build defenses at all points where a landing would be possible;" hence they added, "let us not construct land batteries but exclusively rely on the movements of powerful and rapid squadrons."

Nevertheless, a squadron can not keep at sea indefinitely without a break, like a group of Flying Dutchmen. It needs coal for its boilers, provisions for the crews, ammunition for the guns, repair shops, and refitting docks for the ships, without mentioning the damages in cruising or battles, which sometimes demand urgent repairs. Hence, the necessity of fortified points being available, in order that the fleet may accomplish its full part, and exercise, if possible, control of the sea, which will be a security against a landing.

To sum up, the means of defense actually in use render hazardous a landing in a hostile country, and in no case should such operation be attempted before securing the command of the sea.—*The Navy.*

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EXTRACTS FROM THE BIMONTHLY ORDNANCE REPORT FOR NOVEMBER-DECEMBER, 1913

THE ORDNANCE BOARD

Test of projectiles fitted with long pointed cast steel caps.—Recent firings with 5-inch, 10-inch, and 12-inch guns, at excess pressures, indicate ample strength of the caps to resist deformation in the bore and in flight. Tests with 6-inch guns at an early date will complete the firing tests of this type of cap.

Determination of drift, 700-pound projectile for mortars.—Firings showed the 700-pound deck piercing shell to have 0.58 degrees greater drift than the cast-iron shell, and an average of 193 yards less range, in the zone in which these projectiles will be used. Excellent uniformity in range was obtained. At a mean range of 14,312 yards the total dispersion of the deck piercing shell was 52 yards and that of the cast iron shell 62 yards.

A. C. Magneto firing device for seacoast cannon with transformer used therewith.—Test in progress.

FRANKFORD ARSENAL

Spring bomb traps and grenades for use with dummy mortar equipment in militia armories.—A design of subcaliber gun for use in dummy mortar and gun equipment with which some promising results have been obtained has been submitted to the ordnance office.

Aerial bombs.—Aerial bombs of various weights have been manufactured and shipped to the Signal Aviation School, San Diego, Cal., for experimental firing. Plungers with varying arming ratio and nondelay primers for use in dummy bombs were made a part of this shipment.

Incendiary projectiles.—An incendiary and illuminating projectile is in course of development.

Humidity control apparatus.—A contract for the installation of such an apparatus is being let. All operations in which the powder of time trains are exposed will be completed in the room in which the humidity is controlled.

Die moulded time train rings.—Experiments are being carried on with a view to developing a satisfactory die moulded time train ring. Time train rings have been moulded accurately to size that either break or are distorted when the powder is pressed in the time train. Further experiments will be conducted.

Device for illustrating burst of shrapnel.—A device which will illustrate the burst of shrapnel with a varying cone of dispersion at different heights of burst is being developed. The device will also illustrate the number of balls per unit of area which will be obtained with various heights of burst on both horizontal and inclined surfaces. The device consists of an adjustable projector which casts a cone of light on a surface divided into equal spaces which surface may be inclined.

Panoramic sight, model of 1913.—The type sight has been completed, tested and shipped to the Chief of Ordnance for examination. This sight was subjected to a very severe jolting test without injury. The sight is also dust and moisture proof.

SANDY HOOK PROVING GROUND

Test of Semple percussion night tracers, Lots 1 and 2.—Thirty tracers assembled to cast-iron shot were fired from 3-inch (15-pounder) gun with service velocity over water. All ignited and burned about ten seconds. Lots passed prescribed test.

Test of Watertown Arsenal 12-inch, 700-pound deck piercing shell, Lot 30.—Three shell, sand loaded, were fired from service 12-inch mortar at a 3-inch special treatment steel plate mounted at 442 feet from muzzle. Angle of impact 54 degrees, striking velocity 935, 930, and 950 feet per second respectively. All perforated plate, first one was recovered broken in two at a point just above rotating band; the other two were recovered in condition for effective bursting. Lot passed prescribed test.

Test of Watertown Arsenal 12-inch, 1046-pound deck piercing shell, Lot 33, 1913.—Two shell, sand loaded, were fired from service 12-inch mortar at a 3-inch special treatment steel plate mounted at 443 feet from muzzle. Angle of impact 55 degrees. Striking velocities 660 and 661 feet per second. Both shell perforated plate and were recovered in condition for effective bursting. Lot passed prescribed test.

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Short Notes

Electric Power on Warships.—In view of the greatly extended applications of electricity in ocean-going vessels of recent times, and the generally very satisfactory results which have been recorded in such cases, it is, at first sight, rather disquieting to learn from the *Pall Mall Gazette* that H.M.S. *Invincible* is to undergo a long refit, at a cost of nearly £200,000, principally in the matter of replacing electric by hydraulic power for operating the guns.

One must not forget, however, that the British Admiralty is an institution with historic prejudices, and although these have been very severely shaken in recent years by the evolution of such things as "Dreadnoughts," steam turbines, Diesel engines, wireless telegraphy, etc.,—innovations which, in the interests of progress, absolutely could not be ignored—such prejudices die hard. We prefer to regard the *Invincible* refit merely as an incident, which in no way reflects on the adaptability of electric power for all purposes on a naval vessel, such adaptability having, in fact, been demonstrated already in certain vessels of the American, Continental and Japanese

Navies, where traditional methods have less influence than in our own. We believe the *Invincible* is the only modern capital ship in the Navy fitted with electric power throughout, and while we regret the unfortunate outcome of the experiment in her case, we feel confident that the difficulties which have been met with will be successfully surmounted in later vessels. —*The Electrical Review.*

Strengthening Axial Fire.—It is interesting to note the plan adopted for increasing the right-ahead fire of the *Queen Elizabeth.* In this vessel the 6-inch guns, well protected by armor, have been so arranged in echelon from the center line forward to the ships' side as to bring them to bear on a right-ahead target in a novel and unusual way. British designers had given up the echelon turret plan of mounting the main armament, after the completion of the first few Dreadnoughts, and in adopting the middle-line plan had materially reduced the strength of their right-ahead and right-astern blow, in exchange for a very powerful fire developed on either broadside by the middle-line system. But no sooner do they return to the secondary battery in battleships that they have eschewed so long, than they use a portion of the secondary fire to increase their right-ahead blow. This shows that they gave up the echelon turret system with reluctance, and have taken the first opportunity to increase the axial fire forward. No doubt the crews of these guns would stand small chance against the fire of an enemy's main armament; but they could fight their guns against torpedo attack, etc.. in seasonable weather, so far, at least, as the forward group is concerned. The plan of mounting the 6-inch guns is an ingenious and clever one, and is fairly one to be copied by other nations who build ships with equal beam. The 15-inch and 6-inch forward guns in the *Queen Elizabeth* will not infertere with each other's fire by means of "blast," owing to the means taken to prevent this occurring. The success or failure of this plan of placing guns will be watched with interest by gunnery experts.—*United Service Gazette.*

The Submarine Cruiser.—There is no department in the British Navy in which more satisfactory progress has been made than in the submarine branch. Starting a long way behind France, who first developed this kind of craft on modern lines, and even behind America with her few boats of the Holland type, we have steadily improved our position until to-day we stand pre-eminent in the world's navies with our means of under-water attack and defence. There was a time when to talk about under-water craft eventually taking on the duties of surface cruisers, in home waters and the near seas, was to expose oneself to ridicule. This, however, is no longer the case, and in naval circles it is anticipated that naval designers will, at no distant date, give the British Navy vessels which will be capable of the double functions of surface and under-water fighting, and also be useful for scouting purposes. The present draw-back is the limited speed of submarines on the surface; but this limit is being daily overcome and the latest vessels can now travel faster over the water, when not submerged, than our earlier type of torpedo boats and destroyers. The tonnage of the latest type of our under-water fighters exceeds 700 tons, which is more than many of the gunboats displaced in our old fleet, and this displacement is still on the increase at such a rate that we shall soon have submarines with displacements as large as our light cruisers. The designers and engineers will then only have to shape and engine these vessels so that a cruiser speed can be obtained, and they will be able to give us submarine-cruisers of the highest possible value for scouting purposes at moderate distances.—*United Service Gazette.*

A New Searchlight.—The French military authorities are experimenting with the Dussaud electric lamp. This consists of a circle of metallic-filament glow lamps set on a revolving disc, with a commutator which lights up each lamp in turn for the fraction of a second while it passes through the focus of a reflector. Owing to the short period for which each lamp is lighted, it can be worked far beyond its normal capacity without destroying it; and it is stated that the Dussaud lamp enables a searchlight to be worked with less than one-tenth of the current required for an ordinary arc lamp. This means a large reduction in the weight of the dynamo, the motor, and the transporting carriage. The new light is to be tried, in the first instance, in military airships.—*Army and Navy Gazette.*

Carbons for Searchlights.—In most searchlights the rays come from the positive crater, and the important point is to have a steady arc. This is about satisfied by the use of a negative carbon of small diameter, but with large apparatus using heavy currents, the small carbon soon becomes red for quite a length and burns up quickly. Should the small carbon be inclosed in a tube, this will cast an objectionable shadow. German constructors reduce the wear of the negative carbon by placing it in gas or vapor containing no oxygen and which takes off the heat. Again, lengthwise or cross grooves in the carbon increase its radiating surface. By using a core in the carbon, of a refractory material, the acrbon consumes faster than the core and this produces a fine point. A good method is to use a current of coal gas escaping from a pipe, and this gas can even be lighted without harm. Solids or liquids, such as naphthaline or petroleum, can also be vaporized by the heat of the arc.—*Scientific American.*

Naval Experience for Officers of Russian Army.—The *Militar Wochenblatt* states that every year 32 lieutenants of the Russian Army (1 from each European, and 1 from the East Siberian Army Corps) will be detached for three months for service on battleships, to initiate them into the organization of the Navy and methods of naval fighting. After their course, these officers must give the result of their observations in a memorandum. Pupils, too, leaving the War Academy, will follow the Naval Maneuvers for some days, and certain officers of the General Staff, on duty in coast districts, will participate in the naval summer operations. On the other hand, pupil officers of the Naval Academy will assist at the Army Autumn Maneuvers.—*United Service Magazine.*

Coast Fortifications.—The old idea of defending the coasts of England with guns has been revived by some colonel, who seriously proposes mounting a 15-inch gun every ten miles all along the coast. Four guns, it is explained, are sufficient to cover sixty miles of coast, allowing each gun an effective range of ten miles, and the cost of these sixty miles is to be £100,000 only.
—*The Navy.*

BOOK REVIEWS

Les Responsabilites de L'Artillerie Francaise en 1870. By Commandant C. Romain. Paris: Librairie Militaire Berger-Levrault, 5-7 Rue des Beaux-Arts. 5½" x 8¾". 129 pp. Paper. 1913. Price 2 fr.

This is a study of the causes of the inferiority of the French field artillery in 1870 as compared with the Prussian field artillery. In 1859 the French artillery had proved its superiority to the Austrian on the battlefields in Italy; in 1866 the Austrian artillery had shown itself far superior to the Prussian: what were the causes of the unexpected inferiority of the French batteries in 1870?

The most important cause was, perhaps, the fact that the Prussians took the lesson of 1866 most seriously. And they owed much to the character of their old chief of artillery, General de Hindersin, who promptly scrapped all of the old smooth bores remaining in the service, established schools of fire and encouraged maneuvers, and, when he could not obtain an allotment for a school of application for field artillery officers, raised the necessary amount by subscription among the officers.

On the other hand, the French were handicapped with a chief of artillery who desired to become a field marshal and practiced an unwise economy in order to gain favor with the emperor. The French took the field in August, 1870, with inferior guns, inferior fuses, and inferior projectiles. The artillery officers themselves were divided as to the relative merits of the new breech-loading rifled guns, firing oblong projectiles with time fuses, and the old smooth bores, firing spherical projectiles which had given such excellent results by ricochet fire in former times.

The French artillery suffered also from the policy of passive defense imposed upon the French army by its leaders. While the French field gun was inferior in range to the German, the French small arm was a hundred per cent more effective than the German small arm. Clearly, therefore, the best policy for the French would have been to approach the German lines so that the superiority of their small arms could have been brought into play. The same offensive policy would have enabled their field artillery to approach within effective range of the enemy. But the French policy of passive defense allowed the Germans to choose their distance. Accordingly, they showed a marked preference for the artillery duel beyond the range of the French small arm and also beyond the effective range of the French field gun.

In discussing the various controversies of the day, the author goes back to first principles, which we are only too inclined to forget. His book should be read by those who are responsible for the condition of war material at the outbreak of war. He shows the great danger arising when a supply department will be satisfied with nothing but absolute perfection in material and squanders valuable time in experiments, leaving the troops meanwhile armed with archaic weapons.

Eng

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KEY

TO

INDEX TO CURRENT MILITARY LITERATURE

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ARGENTINE

Ar-0.5	*Anuario del Instituto Geografico Militar de la Republica Argentina* 3^{a} Division del Estado Mayor del Ejército Buenos Aires	Annual
Ar-1	*Boletin del Centro Naval* Florida 659, Buenos Aires	Bimonthly Per year $\$^{m}/_{n}$11.90
Ar-1.5	*Revista del Circulo Militar* 255 Maipu Buenos Aires	Monthly Per year $12.00
Ar-2	*Revista Militar* Ministerio de Guerra, Santa Fe 1461 Buenos Aires	Monthly Per year $\$^{m}/_{n}$9.00

AUSTRIA

Au-1	*Mitteilungen aus dem Gebiete des Seewesens* Pola	Monthly Per year 17 M
Au-2	*Mitteilungen ueber Gegenstaende des Artillerie-und Genie-Wesens* Getreidemarkt 9 Wien, VI.	Monthly Per year 20 M
Au-3	*Streffleurs Militaerische Zeitschrift zugleich Organ der militaerwissenschaftlichen Vereine* I. Graben, 13. Wien	Monthly Per year 28 M
Au-4	*Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines* I. Eschenbachgasse, No. 9 Wien	Weekly Per year 34 K

BELGIUM

Be-1	*Belgique Militaire, La* Rue Albert de Latour 50 Schaerbeck, Brussels	Weekly Per year 12 fr 50

Be–2	*Revue de l'Armée Belge* 24 Rue des Guillemins, Liege	Bimonthly Per year 13 fr
Be–3	*Revue de l'Ingénieur et Index Technique* 70, Boulevard d'Anderlecht, Brussels	Quarterly Per year 30 fr
	BRAZIL	
Br–1	*Boletim Mensal do Estado Maior do Exercito* Ministerio de Guerra Rio de Janeiro	Monthly
Br–2	*O Tiro* Rio de Janeiro	Monthly
Br–3	*Revista Maritima Brazileira* Rua D. Manoel n. 15 Rio de Janeiro	Monthly Per year 12$000
	CHILE	
C–1	*Memorial del Estado Mayor del Ejercito de Chile* Talleres del Estado Mayor-General Santiago	Monthly
C–2	*Revista de Marina* Casilla del Correo 976, Valparaiso	Monthly Per year $15.00
	COLOMBIA	
Co–1	*Memorial del Estado Mayor del Ejercito de Colombia* Jefe del Departamento de Historia del Estado Mayor-General Bogota	Bimonthly Per year $0 50 oro
	DENMARK	
D–1	*Militært Tidsskrift* Copenhagen	Semimonthly Per year 8 kr
	ECUADOR	
E–1	*Boletin del Estado Mayor General* Quito	Monthly Per year $1.00
	FRANCE	
F–1	*Archives Militaires* Librairie Militaire Berger-Levrault 5-7 Rue des Beaux-Arts, Paris	Quarterly Per year 14 fr
F–2	*France Militaire, La* 10 Rue Danton, Paris	Daily Per year 32 fr
F–3	*Génie Civil, Le* 6 Rue de la Chausée d'Antin, Paris	Weekly Per year 45 fr
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F-16	*Yacht, Le, Journal de la Marine* 55 Rue Chateaudun, Paris	Weekly Per year 32 fr

GERMANY

G-1	*Artilleristische Monatshefte* Bernburgerstr. 24-25 Berlin, S. W. 11	Monthly Per year 27 M
G-2	*Eisen-Zeitung* Verlag von Otto Elsner, Berlin, S. 42	Weekly Per year 12 M
G-3	*Ingenieur, Der* Verlag Buchdruckerei F. Posekel, Gneisenaustrasse 67, Berlin S. 61,	Semimonthly
G-3.5	*Kriegstechnische Zeitschrift* E. S. Mittler & Sohn Königliche Hofbuchhandlung, Kochstrasse, 68-71, Berlin, S. W.	10 Nos. per yr. Per pear 10 M.
G-4	*Marine Rundschau* Koch Strasse, 68-71, Berlin, S.W.	Monthly Per year 10 M
G-5	*Militaer Wochenblatt* *With monthly Supplement* Koch Strasse, 68, Berlin, S.W., 12	3 times a week Per year 18 M
G-6	*Schiffbau* Zimmerstr. 9, Berlin, S.W., 68	Semimonthly Per year 20 M
G-8	*Ueberall* Verlag: Boll und Pickardt Berlin, N.W. 7	Monthly Per year 15.6 M
G-9	*Zeitschrift fuer das Gesamte Schiess-und Sprengstoffwesen* J. F. Lehmann's Verlag, Paul Heysestrasse 26, Munich	Semimonthly Per year 26 M

HOLLAND

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H-2	*Wetenschappelijk Jaarbericht. Vereeniging ter beoefening van der Krijgswetnschap* Z. O. Buitensingel 224 The Hague	Yearly Per year 2 florins

ITALY

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I-2	*Rendiconti delle Esperienze e Degli Studi Eseguiti Nello Stabilimento di Esperienze e Costruzioni Aeronautiche del Genio* Viale Giulio Cesare N. 2, Rome	Occasional Per year 13.50 L
I-3	*Rivista di Artiglieria e Genio* Tipografia Enrico Voghera Via Astalli 15, Rome	Monthly, ex. July Per year 20 L
I-4	*Rivista Marittima* Officina Poligrafica Italiana Rome	Monthly Per year 25 L

MEXICO

M-1	*Boletin de Ingenieros* War Dept., Mexico City	Monthly
M-2	*Revista del Ejercito y Marina* Departamento de Estado Mayor City of Mexico	Monthly

NORWAY

N-1	*Norsk Artilleri-Tidsskrift* Christiania	Bimonthly Per year 6 kr
N-2	*Norsk Militært Tidsskrift* Christiania	Monthly Per year 8 kr

PERU

Pe-1	*Boletin del Ministerio de Guerra y Marina* Apartado de Correo No. 91, Lima	Fortnightly

PORTUGAL

Po-1	*Anais do Club Militar Naval* 43 Rua do Carmo, Lisbon	Monthly Per year 4$200
Po-2	*Revista de Artilharia* Rua do Carmo, 43, 2°., Direito, Lisbon	Monthly Per year 3$000 rs
Po-3	*Revista de Engenheria Militar* 27 Rua Nova do Almada, Lisbon	Monthly Per year 3$600 rs
Po-4	*Revista Militar* Largo da Annunciada, 9, Lisbon	Monthly Per year 3$000 rs

RUSSIA

R-1	*Imperial Nicholai War Academy Recorder, The* St. Petersburg	Monthly Per year 6 rubles
R-2	*News of the Officers' Artillery School* Zarskoe Selo	Monthly Per year 10 rubles

SPAIN

Sp-1	*Informacion Militar del Extranjero* Madrid	Monthly
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Sp-3	*Revista Cientifico-Militar* Paseo de San Juan, 201, Barcelona	Semimonthly Per year 40 ps
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SWEDEN

Sn-1	*Artilleri-Tidsskrift* Artillerigarden, Stockholm	Bimonthly Per year 6 kr

SWITZERLAND

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Sd-2	*Revue Militaire Suisse* Avenue Juste Olivier, Lausanne	Monthly Per year 15 fr
Sd-3	*Schweizerische Monatschrift fuer Offiziere Aller Waffen* Frauenfeld	Monthly Per year 5 fr
Sd-4	*Schweizerische Zeitschrift fuer Artillerie und Genie* Frauenfeld	Monthly Per year 8 fr

UNITED KINGDOM OF GREAT BRITAIN AND IRELAND ITS COLONIES AND POSSESSIONS

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UK-3	*Army Review, The* Wyman & Sons, Ltd. Fetter Lane, London, E. C.	Quarterly Per copy 1s
UK-4	*Canadian Military Gazette* Room 16, Trust Bldg. Ottawa, Canada	Semimonthly Per year $2.50
UK-5	*Commonwealth Military Journal, The* Melbourne, Australia	Quarterly
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UK-21	*Royal Engineers Journal, The* Chatham	Monthly Per year 15s
UK-22	*Transactions of the Canadian Institute* 58 Richmond Street, Toronto, Canada	
UK-23	*Transactions of the Canadian Society of Civil Engineers* 176 Mansfield Street Montreal, Canada	
UK-24	*Transactions of the Institution of Naval Architects* 5 Adelphi Terrace, London, W. C.	
UK-25	*United Service Gazette* 43, 44 Temple Chambers London, E. C.	Weekly Per year £1 10s 6d
UK-26	*United Service Magazine* 31, Haymarket London, S. W.	Monthly Per year £1 1s

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US-64	*Science Conspectus* Massachusetts Institute of Technology Boston, Mass.	Five issues per yr.
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US-76L	*Virginia Magazine of History and Biography, The* Virginia Historical Society Richmond, Va.	Quarterly Per year $5.00

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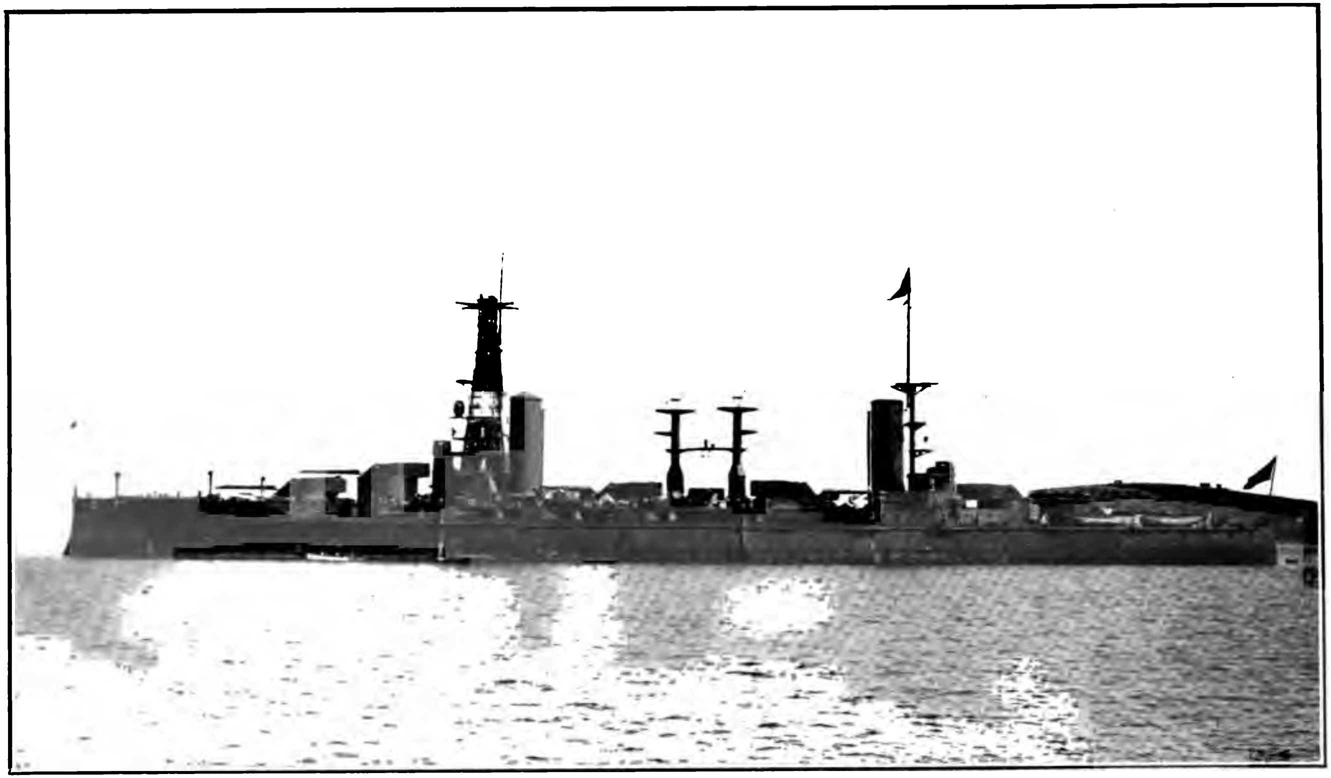

1403

Photograph by Frank C. Perkins, Buffalo, New York.

ARGENTINE BATTLESHIP "RIVADAVIA"

Displacement, 30,600 tons; length, 585 feet; beam, 98 feet. Armament: twelve 12-inch; twelve 6-inch; and sixteen 4-inch guns. Speed 22½ knots.

JOURNAL
OF THE
UNITED STATES ARTILLERY

[illegible] [illegible] [illegible]

First Prize Essay Competition of [illegible]

[illegible]

By Captain [illegible], Coast Artillery Corps

I. Definition

A submarine mine consists of a case containing a charge of explosives, with firing device, moored at or below the surface of the water, intended to be exploded by or against the submerged portion of a hostile ship and thus disable her. The broad distinction between mines and torpedoes lies in the idea of motion, which does not enter into [illegible] of a mine, but into a torpedo. This results in the inclusion of so-called "floating mines" in the category of torpedoes.

II. History

Considering the brief space allotted to this subject, a detailed history of submarine mining is manifestly impossible, and so a fleeting glance at the principal landmarks is all that will be attempted. We shall not discuss here the numerous attempts to use [illegible] ships* as they have little in common with our present mines, being fundamentally different in principle. In the sixteenth and seventeenth centuries, many attempts were made to use these engines [illegible]

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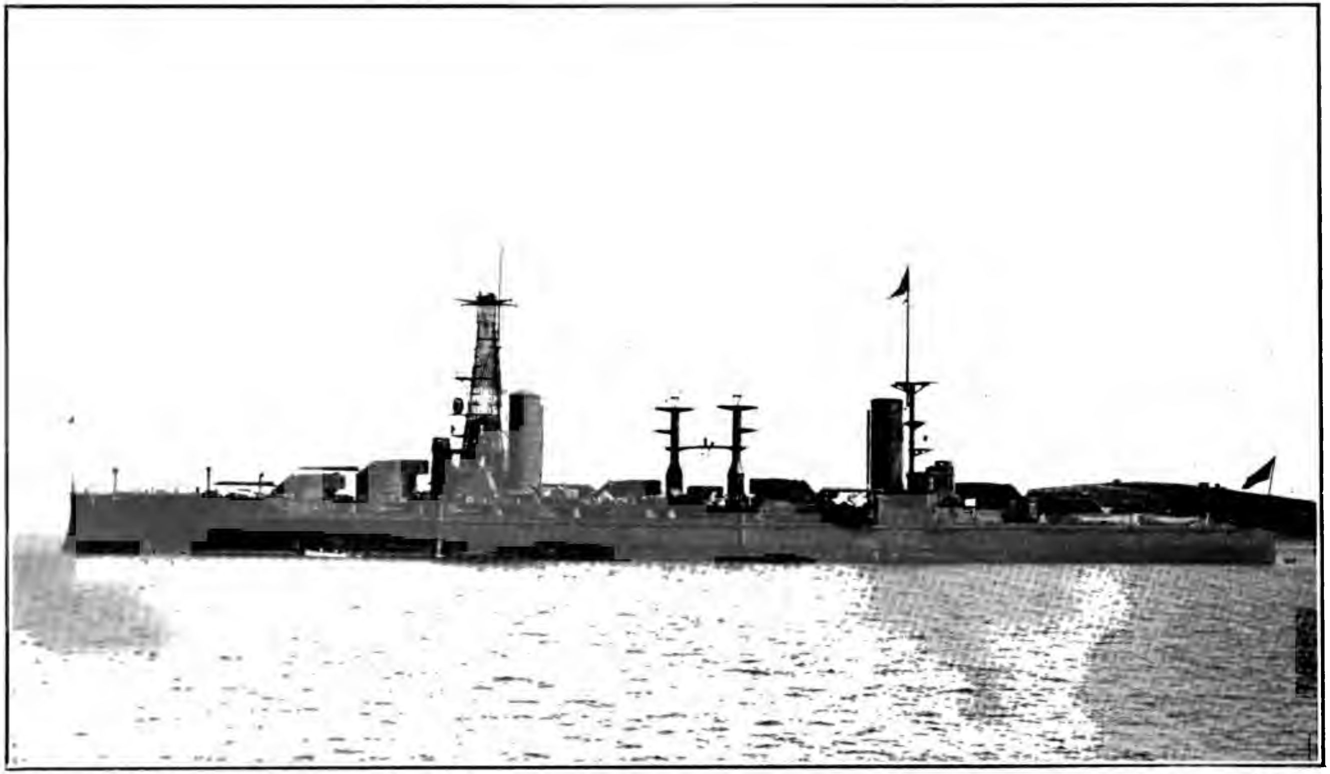
* For description of these early attempts, see Submarine Mines and Torpedoes by Captain-Lieutenant [illegible], German Navy.

Frontispiece.



Photograph by Frank C. Perkins, Buffalo, New York. 1403

Argentine Battleship "Rivadavia"

Displacement, 30,600 tons; length, 585 feet; beam, 98 feet. Armament: twelve 12-inch; twelve 6-inch; and sixteen 4-inch guns. Speed 22½ knots.

JOURNAL
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UNITED STATES ARTILLERY

VOL. 41 No. 2 MARCH—APRIL, 1914 WHOLE No. 126

First Prize, Essay Competition of 1913

THE MINE DEFENSE OF HARBORS: ITS HISTORY, PRINCIPLES, RELATION TO THE OTHER ELEMENTS OF DEFENSE, AND TACTICAL EMPLOYMENT

BY CAPTAIN PAUL D. BUNKER, COAST ARTILLERY CORPS

I. DEFINITION

A submarine mine consists of a case containing a charge of explosives, with firing device, moored at or beneath the surface of the water, intended by its explosion to act against the submerged portion of a hostile ship and thus disable her. The broad distinction between mines and torpedoes lies in the idea of motion, which idea is inseparable from our conception of a torpedo. This results in the inclusion of so called "drifting mines" in the category of torpedoes.

II. HISTORY

Considering the brief space allotted to this subject, a detailed history of submarine mining is manifestly impossible, so a fleeting glance at the principal landmarks is all that will be attempted. We shall not discuss here the numerous attempts to use fire-ships or mine-ships,* as they have little in common with our present mines, being fundamentally different in principle. In the sixteenth and seventeenth centuries, many attempts were made to use these engines, but the results were never more than trifling, and the excessive cost of the experiments resulted in their being abandoned.

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* For description of these early exploits, see *Submarine Mining and Torpedoes* by Captain-Lieutenant F. Von Ehrenkrook, German Navy.

The submarine mine, properly so called, is an American product invented and perfected by Americans, and to America belongs the principal credit for the honorable place now given it as an engine of warfare. Condensed to the smallest compass, the history of the mine is as follows: Bushnell invented it, Fulton improved it, Colt added the electrical element, the Confederates legalized it, and General Abbot perfected it. Other changes and improvements have been made by officers now living, but their work is less important than that of the above mentioned pioneers.

Universal opinion concedes to David Bushnell,* of Connecticut, the title of father of submarine mining. While a student at Yale, he discovered and established experimentally the fundamental principle of the art, that of affecting a ship's bottom by a sub-aqueous explosion. All prior schemes referred to attack at or above the waterline. Purely as a means of placing his torpedoes beneath the hull of a ship, he invented and built a submarine boat, called the "American Turtle." While not within the strict limits of this article, it may be interesting to do more than mention this invention, the first submarine that ever went into action. Fig. 1 is a drawing made by the writer from the four extant descriptions† of this boat. It differs in two principal points from Fig. 2, a reproduction of the only other drawing of this vessel ever made, one by (then) Lieut. F. M. Barber, U. S. N., in 1875.‡ These points refer to the propellers and to the steering mechanism, and the reader will be able to judge from the descriptions which of the two drawings is more nearly correct.

---

* David Bushnell (1742-1826), was born in Saybrook, now Westbrook, Conn. He entered Yale in 1771, was graduated in 1775, and thereafter devoted all his time and money to submarine warfare. He was commissioned in the Corps of Sappers and Miners in 1779 and promoted captain on June 8, 1783. Disheartened by his failures and the neglect of the Government he went to France, but afterwards returned under the name of Dr. Bush and settled in Georgia. Here he became connected with one of the principal schools of the state and later acquired a comfortable fortune by practicing medicine. His real name was disclosed in his will.

(*Hist. Coll. of Georgia*, (White); *American Mechanics*, (Howe), pp. 136-145; Abbot's *Bushnell's Submarine Warfare, Prof. Papers No. 3, Eng. Sch. of Application*, Willets Point.)

† a. *Coll. Conn. Hist. Soc.*, Vol. II, p. 315, corresp. of S. Deane.
b. *Thacher's Military Journal During the Rev. War*, p. 121.
c. *Am. Journal of Science*, Vol. II, (1820) p. 94.
d. *Trans. Am. Philos. Soc.*, Vol. IV, p. 303 (Bushnell's description).

‡ *Lecture on Submarine Boats and Their Application to Torpedo Operations;* Lieut. F. M. Barber, U.S.N., U.S. Torpedo Station, Newport, R. I., 1875.

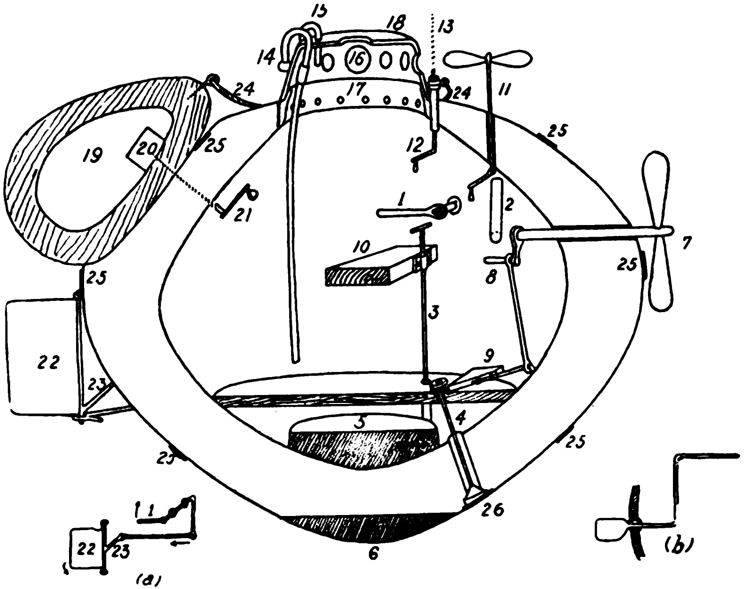
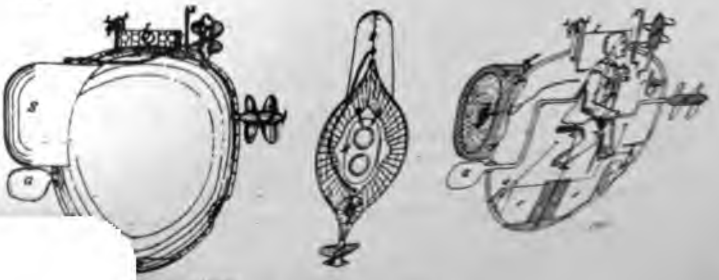


FIG. 1.

1404

1. Inside tiller.
2. Submergence indicator.
3. Hand force pump.
4. Sea valve.
5. Permanent lead ballast.
6. Detachable ballast.
7. Propeller (traction).
8. Propeller crank.
9. Propeller treadle.
10. Seat for operator.
11. Propeller for changing submergence.
12. Crank for operating wood-screw, 13.
14. Air intake with automatic valve.
15. Air outlet with automatic valve.
16. Ports and bull's-eyes.
17. Re-inforcing collar.
18. Hinged brass "crown."
19. Explosive magazine.
20. Clockwork firing mechanism.
21. Safety releasing screw.
22. Rudder with tiller, 23.
24. Magazine mooring line.
25. Iron reinforcing hoops.
26. Strainer for sea valves.



arine Mining.

FIG. 2.

BUSHNELL'S AMERICAN TURTLE

l's

M. F.

The general shape of the vessel was that of a "round clam," every cross-section being as nearly elliptical as possible. "In length it doth not exceed seven and a half feet from the stem to the higher part of the rudder: the height not exceeding six feet." The hull was made of heavy pieces of oak, scooped out, fitted and fastened together with iron bands, and calked with pitch. The air pipes (14,15) in the "crown" were fitted with valves that closed automatically upon submergence. About 200 pounds of the lead ballast (6) could be dropped in case of emergency. To descend, the operator opened the sea-valve (26) with his foot, thus permitting water to enter; to rise, he ejected the water by means of a force pump (3), of which there were two. Phosphorus or "fox-fire" was used in the water gauge (2) and in the compass to permit observations of submergence and course, respectively, at night or when deeply submerged.

For navigation, use was made of two "oars," one of which (7) pulled the vessel along, while the other (11) gave it a vertical motion. Barbers' drawing shows these to be modeled on solid helical screws. Ezra Lee, however, who actually operated the vessel, says:

> This object (horizontal motion) was effected by means of two oars or paddles, formed precisely like the arms of a windmill, which revolved perpendicularly upon an axletree that projected in front. * * * These paddles were but twelve inches long and about four wide. Two smaller paddles of the same description, also projected near the head, provided with a crank inside, by which the ascent of the ship could be assisted.

This seems to prove to most of Bushnell's admirers that he was the first to adapt the principle of the modern propeller to navigation.

As regards the steering mechanism, Bushnell himself describes it as follows:

> A rudder, hung to the hinder part of the vessel, commanded it with the greatest ease. The rudder was made very elastic, and might be used for rowing forward. Its tiller was within the vessel at the operators right hand [in order to include it in Fig. 1 it is shown at the left hand] fixed at a right angle on an iron rod which passed through the side of the vessel; the rod had a crank on its outside end, which commanded the rudder by means of a rod extending from the end of the crank to a kind of tiller fixed upon the left hand of the rudder. Raising and depressing the first mentioned tiller turned the rudder as the case required.

The sketch at Fig. 1 (a) shows schematically the writer's interpretation of this mechanism; that at Fig. 1 (b) shows Lieut. Barber's interpretation.

With this craft Sergeant Lee made an attempt to destroy the British ship *Eagle* off Staten Island. The scheme was to drive the wood-screw (13) into the bottom of the ship; then, by backing off on the cranks (12 and 21), the magazine (19) was to be floated up in contact with the ship's hull, being moored thereto by means of the rope (24). Either due to the fact that he could exert but little pressure to start the screw into the ship's bottom or due to his striking ironwork, he was unable to attach the magazine in the short space of time at his disposal. Upon his return trip he cast off the magazine, which exploded successfully, to the wonderment of those not in the secret.

Later, with but partial success, Bushnell made an attack with towing torpedoes upon the British near New London. In December, 1777, he set adrift a number of keg torpedoes (submerged beneath buoys) in the Delaware River above Philadelphia; but, on account of the ice and the resultant fact that to escape it the British ships had been warped into the wharves, no success attended the venture beyond the production of the famous "Battle of the Kegs."*

It can be seen from the foregoing that Bushnell's main idea was to place his explosive against the bottom of the hostile ship. As Sueter† says:

> He will always be remembered as the inventor of the first submarine that actually went into action * * The following points stand to his credit:
>
> * * * * * *
>
> 2. That gunpowder could be made to explode under water.
> 3. That the bottom of a ship is the most vulnerable part to attack with an explosive charge.

After Bushnell abandoned the prosecution of his ideas, they remained unused for about twenty years, when they were taken up by Robert Fulton, who exerted the whole of his fertile genius to improve them and to force recognition of mining as a legitimate means of warfare. In August, 1801, he blew up a small vessel in the harbor of Brest by means of a charge of twenty pounds of gunpowder which he fastened to the bottom of the hulk by means of his very creditable submarine boat. He failed, however, to induce the French Government to further his projects, principally because he insisted that he and his crew should be recognized as legitimate belligerents by letters patent and that regular commissions should be issued. As a sample of the public opinion at that time, Admiral le Pelly would not permit Fulton to make a submarine attack on a certain British war ship because he had "conscientious scruples against such a terrible invention."

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* For a full account of Bushnell's operations, see Abbot's *Bushnell's Submarine Warfare.*

† *The Evolution of the Submarine Boat, Mine and Torpedo,* Comdr. M. F. Sueter, R. N., 1908, p. 25.

Fulton went to London in 1804 and after interviewing the British Admiralty was invited before a commission that was appointed to examine into and to report upon his schemes. This the commission did, declaring the plunging boat system entirely impracticable.

In October 1804 occurred the "Catamaran Expedition,"* so called on account of the floating torpedoes devised by Fulton for the British in that attack upon the French fleet at Boulogne. Fulton attributed his failure mainly to the fact that the explosions occurred at the surface of the water and not below the ships. He then designed a form of coupling, shown at the left in Fig. 3, with which he blew up the brig *Dorothea* near Deal, October 15, 1805, in the presence of a brilliant assemblage.† The harpoon part of this apparatus was designed later. Fig. 4 shows a mine proper that he designed at about this time.

The result of the successful experiment on the *Dorothea* was surprising for Fulton. It alarmed England. Her navy was supreme, and naturally she would have nothing to do with methods that would tend to weaken or endanger the importance of naval power. The British felt that "Pitt was the greatest fool that ever existed, to encourage a mode of war which they who commanded the sea did not want, and which, if successful, would deprive them of it."

Fulton, therefore; finding all support in England withdrawn, decided to test the judgment of his native land; and, arriving in New York in December, 1806, he laid his schemes before the authorities in Washington. He was finally allotted a small sum, and after many miscarriages and delays, finally succeeded in blowing up a small vessel in New York Harbor on July 20, 1807, by means of the arrangement shown in Fig. 3. However, as the explosion took place some hours after the advertised time, the general public decried the experiment as an ignominious failure. But Fulton would not quit; he published his famous pamphlet, *Torpedo War: or, Submarine Explosions*, and by dint of unceasing effort secured from Congress an allotment of $5000 for the practical test of his projects. A commission* was appointed to witness the test and to report on it. The sloop-of-war *Argus*, then at the New York yard, was turned over to the commission for use in the test. By this time Fulton had abandoned his submarine

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* *Naval History of Great Britain*, James; *History of the British Navy*, Yonge; *Battles of the English Navy*, Allen; *Prof. Papers No. 1, Eng. Sch. Applc.* For French Official account see *Naval Chron.*, Vol. XIV, p. 339.

† *Naval Chron.*, Vol. XIV, p. 342.

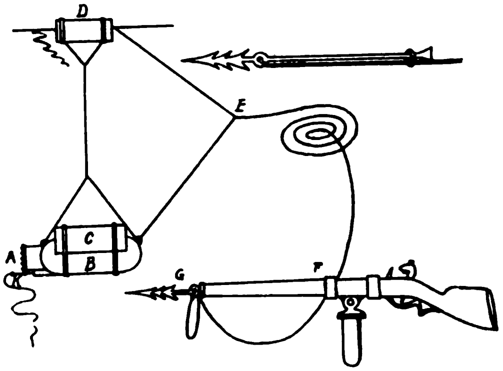

FIG. 3. 1406

A. Waterproof gun-lock.
B. Explosive case.
C. Cork cushion.
D. Pine box of cork.
E. Coupling.
K. Safety pin.

Charge, 100 pounds powder; buoyancy of D, 10-15 pounds; length of suspending line usually greater than the draft of the ship attacked.

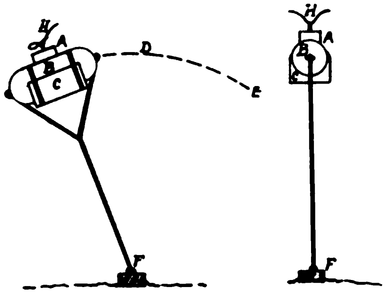

FIG. 4. 1407

A. Waterproof gun.
B. Copper case, 2′ × 1′.
C. Cork cushion.
D-E. Tidal swing.
F. Anchor.
H. Trigger.

General characteristics, same as shown in Fig. 3, except that it is exploded by contact, instead of by clockwork, as is the case in Fig. 3.

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* The Commission consisted of Chancellor Livingston, Morgan Lewis, C. D. Colden, John Kemp, Oliver Wolcott, John Garnett, and Jonathan Williams. Commodore Rodgers and Captain Chauncey were ordered to assist in every way in giving the system a fair trial.

boat; he was still using the device shown in Fig. 3 and evolved the harpoon idea during the experiments. Unfortunately for himself, he explained to the commission beforehand his method of attack; whereupon Commodore Rodgers took charge of preparing the *Argus* to receive the attack. The gallant Commodore fitted her with nets reaching to the ground, booms, weights that could be dropped from the yard-arms, scythes on the ends of spars, and other wondrous defenses, until the vessel looked more like a museum than a war ship. In fact, she was so encumbered that she could hardly fight as a regular man-of-war, and could not be maneuvered.

When the commission met, Fulton was taken by surprise; and, after he had tried in vain to overcome the obstacles imposed by Commodore Rodgers,modestly admitted the ingenuity of the latter. The commission almost unanimously took a sensible view of the whole proceeding, and were impressed with the ultimate value of the new means of warfare. Not so Commodore Rodgers, who, with the bluff intolerance of a sailor overproud of his profession, strained every nerve to bring Fulton's schemes into disrepute. The commissioners acknowledged the attacks to have failed (through the antagonsim of the "nautical gentleman") but urged the necessity of Federal aid in perfecting the scheme.* However, as Commodore Rodgers' report was given more weight at the Navy Department than the others, and as he considered that Fulton's "torpedoes, so far from being of the importance which he had considered them, were, on a more thorough examination of their principles, assisted by all the practice of which he himself had supposed them susceptible, found, to say the least, *comparatively of no importance at all;* consequently they ought not to be relied on as a means of national defence"; as a result of all this, it is easily seen that Fulton's support by the Navy Department was withdrawn almost immediately. Fulton, before giving his attention to steam engineering, bade farewell to the subject of submarine warfare in a letter to the Secretary of the Navy, from which the following extracts are taken:

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* Mr. Lewis, in his report says: "The submarine use of gunpowder will, at no distant day, be entitled to rank among the best and cheapest defenses of ports and harbors."

Chancellor Livingston said, among other things: "Upon the whole, I view this application of powder as one of the most important military discoveries which some centuries have produced."

Mr. Colden said: "* * this application of gunpowder might produce greater changes in the world than have been made by it since its introduction into Europe."

> It is proved and admitted, first, that the waterproof locks will ignite gunpowder under water. Secondly, it is proved that 70 pounds of gunpowder exploded under the bottom of a vessel of 200 tons will blow her up; hence it is admitted that if a sufficient quantity—and which I believe need not be more than 200 lbs.—be ignited under the bottom of a first-rate man-of-war, it would instantly destroy her. * * * With these immensely important principles proved and admitted, the question naturally occurs whether there be within the genius or inventive faculty of man, the means of placing a torpedo under a ship in defiance of her powers of resistance.
>
> He who says there is not, and that consequently torpedoes can never be rendered useful, must of course believe that he has penetrated to the limits of man's inventive powers, and that he has contemplated all the combinations and arrangements which present or future ingenuity can devise, to place a torpedo under a ship.
>
> I will now do justice to the talents of Commodore Rodgers. The nets, booms, kentledge, and grapnels which he arranged around the *Argus* made at first sight a formidable appearance against *one torpedo-boat and eight bad oarsmen.* I was taken unawares. I had explained my means of attack, they did not inform me of their measures of defense * * I have now, however, had time, and I feel confident that I have discovered a means which will render nets to the ground, booms, oars with sword-blades through the port-holes and all such operations, utterly useless.

During the War of 1812 several attempts were made to blow up British war ships. All were unsuccessful, and resulted in nothing more than a general feeling of alarm in the minds of the British skippers and harsh retaliatory orders on the part of several naval commanders.*

After the War of 1812 nothing more was heard of torpedoes or mines until 1829, when Samuel Colt started his series of experiments which culminated in his public exhibitions of 1842-3. The main idea underlying all of Colt's work was the utilization of an electric current for exploding his mines. On June 4, 1842, he exploded a mine in New York Harbor; and exactly a month later he repeated the experiment opposite Castle Garden, completely demolishing the old gunboat *Boxer*. In August, 1842, in the presence of the President and various heads of departments, he destroyed a schooner on the Potomac, while stationed at a distance of about five miles from the scene of the explosion. These experiments had great weight with Congress and the people at large, and secured Colt a grant of $17,000 to further his schemes. On October 18, 1842, Colt blew up the brig *Volta*, 300 tons, in New York Harbor, in the presence of a brilliant throng. But his crowning achievement took place on April 13, 1843, on the Potomac River, when he destroyed a brig of 500 tons, at a distance of five miles, while she was under way, sailing at a rate of at least five knots. Congress adjourned to see this test. In spite of its unqualified success, this was Colt's last experiment with mines. Due to the opposition of Col. Totten and most naval authorities, no further support was given him, and history recorded another case of unrequited genius. To Col. Colt is probably due the credit of being the first to explode mines electrically,* and of inventing the first submarine cable. At the time of his death he had also devised means of automatic firing and of causing his mine to signal when contact with a ship had been made.

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* The following is a copy of an indorsement upon the papers of an American schooner:

H. M. S. *La Hogue*, At Sea, 8 July, 1913.

"I have warned the Schooner *Sallie* of Barnstable to proceed to her own coast, in consequence of the depredations of the *Young Teazer*, * * but more particularly from the inhuman and savage proceedings of causing the American schooner *Eagle* to be blown up, after she had been taken possession of by H. M. S. *Ramilies*—an act not to be justified on the most barbarous principle of warfare. I have directed H. B. M. cruisers on the coast to destroy every description of American vessels they may fall in with, flags of truce only excepted.

"Given under my hand, etc.
Thomas P. Capel, Captain."

—*Niles' Reg.*, Vol. IV., p. 337.

During the Schleswig-Holstein War of 1848-50, Prof. Himly invented and installed mines composed of 300 lbs. of gunpowder in wine casks, and exploded by dip batteries. They were planted at Kiel but were not used. It is said that one of these mines was found in 1873, and that the interior was still dry.

During the Crimean War of 1854-6 the Russians used mines to a considerable extent but without results, due principally to the wariness of their antagonists. The arrangements for exploding these mines included both chemical and electrical means. The former consisted of an arrangement whereby a glass tube containing sulphuric acid was broken when a ship struck the mine, whereupon the acid coming into contact with a mixture of potassium chloride and sugar caused the inflamation of the mine charge. This was the first appearance of this device, known as Jacobi's fuse, but it was by no means the last, as the Confederates used it freely, and foreign nations also have utilized it.

During the Anglo-Chinese War of 1857-8 the Chinese attempted to make use of mines, the ideas of which they seem to have acquired from an American. No damage was done†.

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* In 1839 General Pasley blew up the *Royal George*, sunk off Spithead, by means of electricity. Particulars are not known.

† For description see *Jour. Royal United Ser. Inst.*, 1871.

In the Austrian-French War of 1859 the harbor of Venice was protected by mines charged with 400 pounds of gun-cotton, submerged twelve feet, and exploded electrically. The position-finding scheme involved the use of a huge camera obscura which was afterwards abolished. The French fleet never attempted to attack Venice, possibly for fear of the mines, and so the system never received an actual trial.

But it was principally during our Civil War that submarine mining rose to its present accepted position as an invaluable means of warfare, and also achieved an honorable place in the profession of arms. Heretofore it had been condemed as barbarous; and indeed, during the first part of this war, similar opinions were held by the great majority of the military and naval commanders.

The use of mining by the Confederates was an apt illustration of the adage, "Necessity is the mother of invention"; and, considering all the circumstances of the case, it is easy to see why the Confederates adopted such energetic means to evolve a service of submarine mines. In the first place, they had practically no navy, and in the second place, they were in dire need of some means of curbing the activity of the Union gunboats, many of them iron-clad, that ascended their rivers, blockaded the coast, and carried menace to all the Confederate States. For such a situation as this, the submarine mine or torpedo is the logical solution; and the Confederates, spurning all formerly held ideas of "infernal machines," grasped eagerly at the opportunity to neutralize the greater naval strength of the North. In a similar manner, when the Northern sailors had experienced contact with a few of these mines, although the necessity for mines was less in their case, they likewise threw to the winds their preconceived notions of chivalry and endeavored to evolve a mining system of their own.

The first torpedo of the war was discovered on July 8, 1861, drifting down Acquia Creek into the Potomac by the U. S. S. *Pawnee*.* The first regular installation of mines was found in the Savannah River near Fort Pulaski in February, 1862. They were designed to be exploded by a hostile vessel running against a cable connecting two or more mines, thereby setting off an ordinary friction primer. No damage was done in this instance.† In October, 1862, the Confederacy inaugurated their Submarine Battery Service, headed at Richmond by the "Torpedo Bureau," which was destined to cause Union admirals so many anxious moments. Agents were sent abroad and the highest talents of Europe were called upon to supply improvements in the system and apparatus, which improvements, incidentally, were not slow in forthcoming.

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* *Sanders' History of the Four Years' Civil War,* by Mangold.

† Chas. Boynton's *History of the Navy during the Rebellion.*

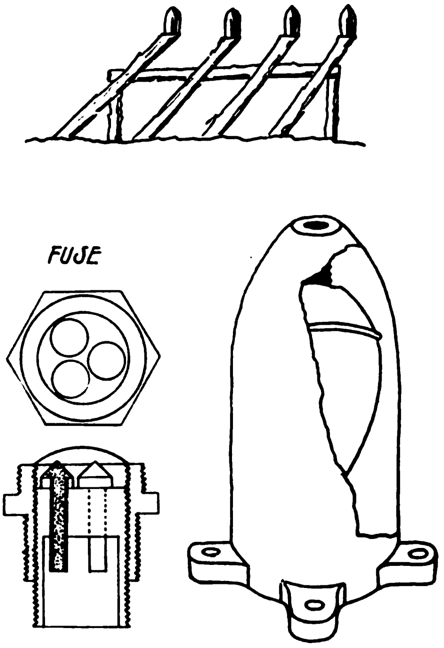

FIG. 5.

FRAME MINES

Top sketch shows method of use.

Lower right hand sketch shows enlarged view of one of the mines, with weakening groove.

The other sketch shows the fuse. A thin diaphragm was soldered over the top. The explosive mixture contained fulminate, ground glass, etc.

Excluding from our consideration the subject of spar-torpedoes, which in themselves constitute an interesting chapter in the subject of submarine warfare, the mines used by the Confederates may be divided into three general classes:

1. Pile, or frame, mines.
2. Mechanical mines. } Buoyant mines.
3. Electrical mines. }

The frame mine is sufficiently explained by Fig. 5. It was used in shallow water, traversable by light draft vessels only. Fig. 6 shows another form that was used in great numbers in the harbors at Charleston, Mobile, and Wilmington, forming very formidable barriers. This drawing was made from a mine found before Fort McAllister after its capture by General Sherman.

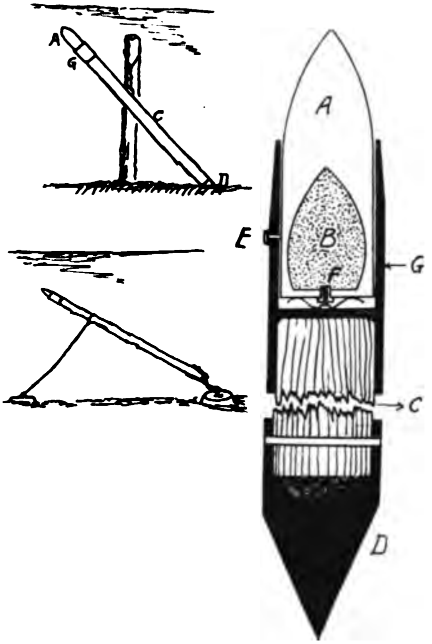

Fig. 6.

Pile Mines

A. Projectile.
B. Explosive.
C. Pile.
D. Driving shoe.
E. Set screw.
F. Fuse, percussion.
G. Pile-head gun.

Sketches at left show methods of use.

For their mechanical mines the Confederates at first utilized beer barrels, as indicated in Fig. 7. Large numbers of these were kept on hand for instant use. They were cheap and easily planted.

Perhaps the most successful mine used during the war was the famous Singer Mine, taken under official consideration by the Confederacy in 1863. It was invented by Mr. E. C. Singer, and was afterwards improved by Capt. MacEvoy and by Sergt. Major Mathieson of the Royal Engineers. As modified by MacEvoy this mine was approximately as shown in Fig. 8.

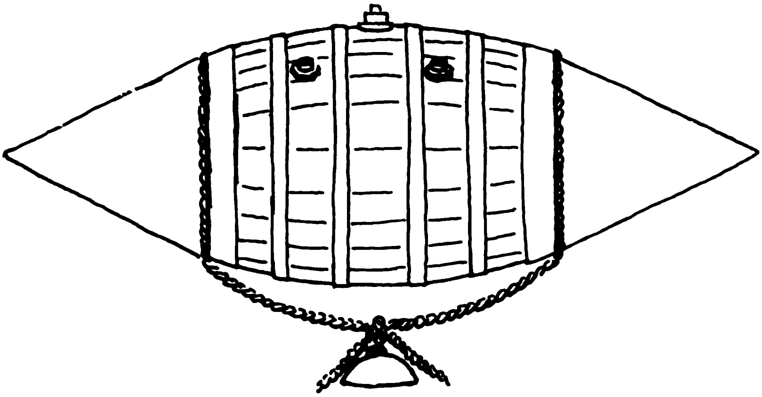

FIG. 7.

1410

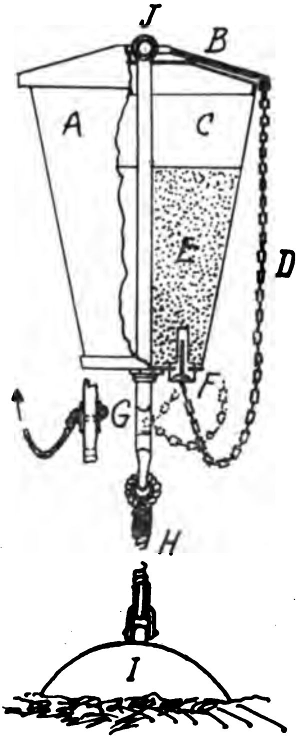

FIG. 8.

1411

When struck by a ship, the cap B was knocked off and, in falling, operated the friction primer F. The mine was planted by means of a bight passed through the eye J, which latter also prevented accidental dislodgement of the cap while planting. After planting, a safety peg was drawn, as shown enlarged at G, by means of a line the free end of which was buoyed. Mathieson's improvement consisted of the substitution of a slowly soluble plug at G for the safety peg arrangement of MacEvoy. Some time after planting, this plug which held the firing chain in the position shown by the dotted lines, dissolved and "set" the mine by freeing the chain. In Singer's original mine, the falling weight released a plunger, which, impelled by springs, operated a Jacobi fuse. The springs were discarded because barnacles clogged them.

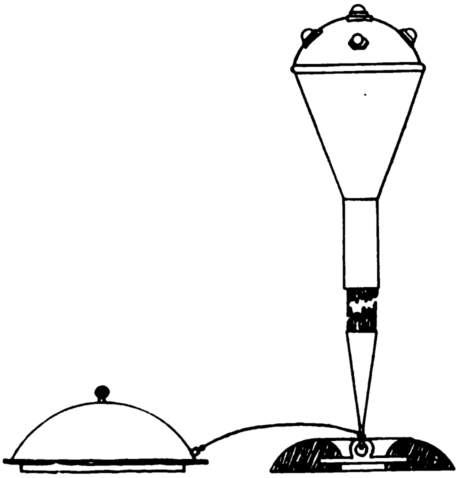

FIG. 9. 1412

The Brooke mine was of the general design shown in Fig. 9. It was supposed to be difficult to remove. It was sometimes connected by a wire to the fuse of a ground mine called a "devil circumventer." The intentions of this arrangement are unmistakable, but there are no records of its successful application.

The most highly developed product of the Torpedo Board was the buoyant electric mine shown in Fig. 10. Mines of this type rarely contained less than a ton of powder, and were usually placed in the principal channels. The fuse operated on the now familiar principle of the platinum wire bridge. Ordinary plunging cells were used as sources of energy, although in the summer of 1864 "Wheatstone's Magnetic Exploder," devised especially for the Confederates, was imported, and to a great extent superseded the comparatively unreliable cells.

In most of their work, the Confederates relied on range stakes for a position finding system.

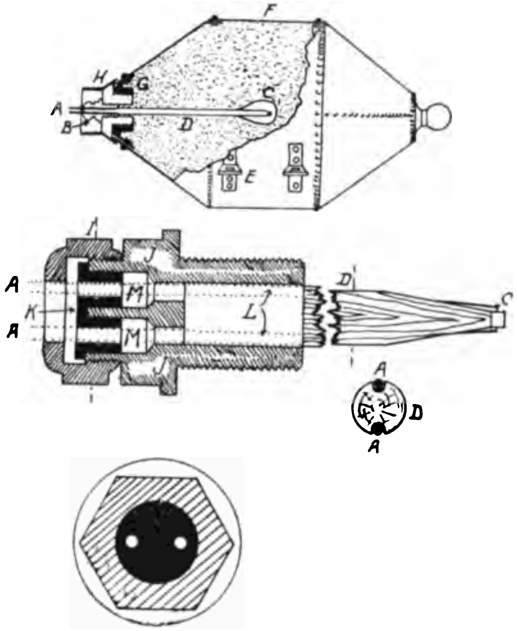

FIG. 10. 1418

A.	Conductors.	H.	Mine plug.
B.	Stuffing box.	I.	Cross-section.
C.	Fuse bridge.	J.	Metal stock.
D.	Grooved stick.	K.	Cylindrical disc.
E.	Mooring ears.	L.	Grooves for wires.
F.	Case.	M.	Space for packing.
G.	Reinforcing.		

Charge, 100 lbs powder.

Bouyancy of D, 10-15 lbs.

Length of suspending line usually greater than the draft of the ship attacked.

Now, having glanced at some of the types of mines evolved, it might be pertinent to inquire into the results obtained. On account of the brief space available for this article a tabulation becomes necessary. This, taken principally from Abbot, gives a summary of attempts with mines during the Civil War. For the benefit of readers desiring more detailed accounts, references to more extensive descriptions are given.

Date	Place	Vessel		Class	Tons	Guns	Mine	Damage	REMARKS
12-Dec-62	Yazoo River	**Cairo*	U.S.N.	Armored	512	13	Two mines	Destroyed	No lives lost. Sank in 12 min. Wires found.
28-Feb-63	Ft. McAllister, Ga.	**Montauk*	U.S.N.	Monitor	844	2	Mechanical	Seriously	Saved by beaching; disabled for a month.
7-Apl-63	Charleston	**Ironsides*	U.S.N.	Armored		18	Electric	None	Poor insulation prevented firing 2000 lbs. powder
22-Jul-63	Yazoo River	**Baron De Kalb*	U.S.N.	Armored	512	13	Singer	Destroyed	No lives lost. Sank in 15 min. Two explosions.
8-Aug-63	James River	**Com. Barney*	U.S.N.	Gunboat	513	4	Electric	Disabled	Poor batteries caused delay.
Sep-63	"	*John Farron*	U.S.A.	Transport		0	(?)	Seriously	
5-Oct-63	Charleston	**Ironsides*	U.S.N.	Armored	3486	18	"David"	Seriously	Submarine boat with spar torpedo.
	"	*Marion*	C.S.N.	Unarmored		0	Keg	Destroyed	Buoyant mine accidentally torn from moorings.
	"	*Etiwan*	C.S.N.	Unarmored		0	Keg	Seriously	At practically same time and place as preceding.
17-Feb-64	"	**Housatonic*	U.S.N.	Sloop-of-war	1240	13	"David" Spar	Destroyed	5 lives lost, also attacking "David."
1-Apl-64	St. John's River	*Maple Leaf*	U.S.A.	Transport	508	0	Floating	Destroyed	
6-Apl-64	"	*Gen. Hunter*	U.S.A.	"	460	0	Floating	Destroyed	
9-Apl-64	Newport News	**Minnesota*	U.S.N.	Flag-ship	3307	52	Spar	Internally	Attacker escaped. 53 lbs. powder used.
15-Apl-64	Red River	*Eastport*	U.S.N.	Armored	800	8	Floating	Wrecked	Probably keg mine, small. See Boynton.
6-May-64	James River	**Com. Jones*	U.S.N.	Gunboat	542	6	Electric	Destroyed	40 killed, ship blown to fragments.
9-May-64	St. John's River	*H. A. Weed*	U.S.A.	Transport	290	0	Floating	Destroyed	
19-Jun-64	" "	*Alice Price*	U.S.A.	"	320	0	Floating	Destroyed	
5-Aug-64	Mobile Bay	**Tecumseh*	U.S.N.	Monitor	1034	2	Electric	Destroyed	Sank almost instantly; only 2 saved.
27-Oct-64	Plymouth	*Albemarle*	C.S.N.	Armored		2	Spar	Wrecked	The only Union success during the war
8-Dec-64	Mobile Bay	*Narcissus*	U.S.N.	Gunboat	101	2	(?)	Destroyed	
9-Dec-64	Roanoke River	*Otsego*	U.S.N.	Gunboat	974	10	Buoyant	Destroyed	Several killed.
9-Dec-64	" "	*Bazely*	U.S.N.	Tug		0	Buoyant	Destroyed	Blown to fragments while trying to help Otsego
15-Jan-65	Charleston	*Patapsco*	U.S.N.	Monitor	844	2	Barrel	Destroyed	Sank instantly nearly all hands lost.
20-Feb-65	Cape Fear River	*Shawmut*	U.S.N.	Cutter		0	Barrel	Destroyed	Small boat from *Shawmut*, while clearing mines.
20-Feb-65	" " "	*Osecola*	U.S.N.	Gunboat	974	10	Barrel	Slightly	Paddle box blown to pieces
(?)	James River	*Schultz*	C.S.N.	Transport		0	Barrel	Destroyed	Mine had broken from moorings. Accidental.
1-Mar-65	Georgetown	*Harvest Moon*	U.S.N.	Gunboat	546	3	(?)	Destroyed	
4-Mar-65	Cape Fear River	*Thorne*	U.S.A.	Transport		0	(?)	Destroyed	
12-Mar-65	Blakely River	*Althea*	U.S.N.	Gunboat	72	1	(?)	Destroyed	Probably most of the mines in Mobile bay were
28-Mar-65	" "	**Milwaukee*	U.S.N.	Monitor	970	4	(?)	Destroyed	McEvoy mines, and the barrel type.
29-Mar-65	" "	**Osage*	U.S.N.	Monitor	523	2	(?)	Destroyed	
1-Apl-65	" "	**Rodolph*	U.S.N.	Gunboat	217	6	Drifting (?)	Destroyed	
13-Apl-65	" "	**Ida*	U.S.N.	"	104	1		Destroyed	Sank in a few minutes.
14-Apl-65	Mobile Bay	**Sciota*	U.S.N.	"	507	5		Destroyed	4 killed.
12-May-65	" "	*R. B. Hamilton*	U.S.A.	Transport	400	0		Destroyed	From Abbot.
6-Jun-65	Ashley River	*Jonquil*	U.S.N.	Gunboat	90	2		Seriously	No details known.

* Barnes' *History of Submarine Warfare*.

Due to the results obtained during our Civil War, every foreign nation of importance started to devise a system of mining; for, as previously noted, it was this war which took the mine out of the class of "infernal machines" and placed it among the honorable means of warfare.

In the Schleswig-Holstein War of 1864 were used large electric mines and also some ingenious mines of the contact type; none, however, were ever in action.*

In the Paraguayan War of 1865-70 against Brazil, Uruguay, and the Argentine Republic, many drifting torpedoes were used by the first named power, but unsuccessfully.† However, on September 2, 1867, the iron-clad *Rio de Janerio* was destroyed, probably by a buoyant mine fitted with a Jacobi fuse.‡

During the Austro-Prussian War of 1866 the Austrians formulated a fairly complete mining system and devised some very good mines, principally of the electric-contact type. No opportunity was found for their active use. On two occasions mines were accidentally fired by lightning.||

During the Franco-German War of 1870-1 the moral effect of the submarine mine was fully demonstrated. The Germans defended their principal harbors and estuaries in the Baltic and the North Sea with mechanical and electro-mechanical mines, the former containing 80-100 lbs. of powder, and the latter 200 lbs. of dualine. The French, giving the mined localities a wide berth, suffered no casualties, but the Germans lost several men in raising the mines.

At about this time the torpedo began to assume such importance that the energies of those interested in submarine mining were bent more particularly toward the development of that weapon. Although all nations endeavored to improve their defensive mine systems, and in every maritime war established mine defenses, it is not until the recent Russian-Japanese War that we again encounter any appreciable results from the use of mines proper. During this interim, however, there were many instances of the use of mobile torpedoes.

General Henry L. Abbot, Corps of Engineers, between

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* For detailed description of contact type see *Papers No. 1, Eng. Sch. of Application*, Willets Point.

† *Der Krieg der Triple Allianz gegen die Rigierung der Republik von Paraguay;* Schneider, Berlin, 1873.

‡ See Barber's *Lecture on Movable Torpedoes.*

|| *Mittheilungen ueber Gegenstaende der Ingenieur und Kriegewissenshaften*, 1868.

1869-75 devised a complete system of mining for our service. The reports of his experiments at Willets Point constitute a classic in the literature of submarine mining, and although his deductions therefrom are not entirely accepted by modern authorities,* they repay careful study by any person desiring familiarity with the subject. His formulated system as used by the Engineers, by whom all our mining operations were carried on at that time, was described in the *Torpedo Manual*, which underwent its final revision in 1898.

Professional Papers No. XI, U. S. Eng. School, published in 1888, gave a detailed comparison between the mining systems used at home and abroad, and the general similarity of these systems is remarkable, differing, in most cases, in minor details only. Our system was probably the best, especially as our welded mine cases were markedly superior to the riveted cases used abroad.

When submarine mining was turned over to the Artillery the whole system was thoroughly revised, practically the only items retained being the circuit closer and the mine case itself. This revision was the work, primarily, of the "Torpedo Board" at Fort Totten, and occurred about 1904. Changes have been made since then, but their minor character speaks volumes for the character of this Board.

The writer has endeavored to give, in the foregoing condensed and inadequate account, a summary of the main historical facts relating to the mine defense of harbors. He has restricted himself to those mines that are handled by the land forces, and has tried to show the development of the controlled mine for this use. The controlled mine is also best adapted to "advanced base" mining by the Navy, but would, of course, be useless for what is known as "fleet mining." For this purpose an "automatic" mine of some type is necessary. Therefore, while no attempt to show the successive steps in developing such mines can be made here, it is felt that some statement of their present status, at least, should be made.

The uses to which such a mine would be put are apparent to the reader. It is also evident that among the other requirements which such a mine must have are those of compactness and of being easily and quickly planted. Naval mines, unless dropped from a planter, are usually sent overboard through a chute. Some nations plant each mine as a separate unit, others plant them in strings with connecting cables.

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* It seems to be the belief at present that General Abbot failed to make proper comparison between the effects of small charges, such as those with which most of his experiments were made, and of the comparatively large charges ordinarily used in mines. The value he deduced for the pressure that would cause fatal rupture of a ship's hull has been questioned, as has also the results of his "Hell Gate Experiments" in deducing the depressing effect of tide upon buoyant mine cases.

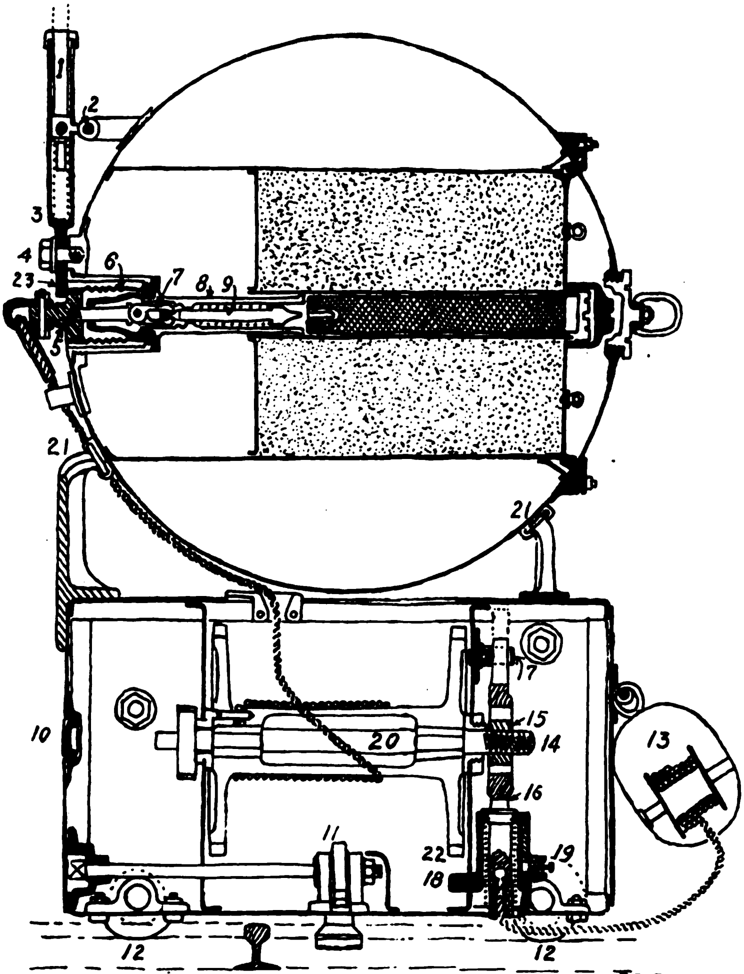


FIG. 11.

Elia's automatic mine.

Some mines are purely mechanical in their action, while others involve the use of batteries, either enclosed in the mine case or in a separate water-tight receptacle at the end of the connecting cable.

It is hoped that from the sketch shown in Fig. 11 a general idea of the present state of development of the mechanical automatic mine can be obtained. As nearly as can be ascertained, this is the latest production of the Vickers works, and represents the result of the many experiments of Mr. G. E. Elia, a most ingenious inventor, formerly of the Italian Navy.

At the instant of planting, the distance weight (13) has dropped below the mine to the full extent of its rope (12) a distance equal to the submergence desired and the mine has been freed from the clips holding it to the anchor at (21). When the mine is planted, the lead distance-weight tends to sink faster than the anchor, therefore the rope (12) keeps a steady tension (by means of its Turk's-head) on the plunger (16). The plunger is pulled down against the spring shown, until it rests upon the free nut (15), thus preventing the latter from rotating with the shaft (14). The buoyancy of the mine keeps it at the surface of the water while the anchor is sinking; meanwhile, the paying out of the mooring rope causes the drum (20) and its shaft (14) to rotate, and the nut (15) to work toward the end of the shaft out of the line of the plunger. When the distance weight strikes the bottom, the plunger rises in its guide (17), the nut now being out of the way, and brings the stop (18) into engagement with the pinion (22) on the flange of the drum (20), thus preventing any further paying out of the mooring rope, and causing the mine to be dragged under. When the plunger rises, the spring-actuated bolt (19) slips under the bottom of the plunger sleeve and thus locks the whole mechanism.

After the mine has been immersed for some time, a soluble plug (not shown) at (2) dissolves and allows the spring-actuated contact arm (1) to slide out as shown in the dotted lines. The mine cannot be fired until this happens, because the contact arm is firmly locked at (2). Now if a ship strikes the mine, two distinct motions will result, the first a rotary motion about a vertical axis and the other a sort of bobbing motion. The first mentioned motion arms the mine and the other fires it. When the ship brushes the mine and sets it rotating, the contact arm, either by actually striking the ship or through its own inertia, swings about the pivot (4) and causes its lip (23) to disengage the firing plunger (5). The surge of the mine against its mooring rope tends to pull the firing plunger down out of the mine case against the action of the firing pin spring, thus stretching and perhaps destroying the flexible waterproofing (6). Now the rear of the firing pin (9) ends in a knob which is gripped by the dogs (7), the latter being fitted with a spring that tends to open their jaws and release the firing pin. This cannot happen, however, until the dogs are pulled back into the enlarged part of the firing pin sleeve. So, when the mine rises through the water after having been knocked down by a ship, the firing plunger is held back by the mooring rope, the firing pin is drawn down against the pressure of its spring until the dogs reach the enlarged portion of the sleeve, when it is released and, impelled by its spring, moves up and sets off the detonator shown just ahead of its point, thus exploding the mine charge.

III. Principles

1. The basic principle of submarine mining, as discovered by Bushnell, is that of attacking a ship by means of exploding a charge as near her bottom as possible.

Such an explosion results in two different phenomena, one a wave motion propagated through the water at a velocity of, say, 4500 f.s., and the other a physical displacement of the water or other matter in the immediate vicinity of the charge. The latter, which might be termed the "direct effect," is our main reliance in destroying hostile vessels; the former, which may be felt over a considerable distance outside the disturbed area, finds its principal application in countermining, and will not be discussed in this article.

A submarine mine gives its maximum results when exploded in contact with the bottom of a ship. In such a case the line of least resistance might and probably would pass through the hull of the ship, and the expansive force of the gases would act in a manner similar to that observed in blasting operations. On the other hand, if the mine were exploded at a suitable distance, the gases might not even approximate actual contact with the hull and the whole destructive effect would be produced by the water projectile formed by the explosion.

In the latter case, as is well known, a small charge exploded close to the hull would ordinarily inflict greater damage than a large charge at a correspondingly greater distance. This is because the stresses from the large charge would be spread over a greater surface of the target and would be distributed more uniformly, whereas the small charge would produce severe local stresses. In other words, the idea is not to try to blow the ship out of the water but merely to make a reasonable breach, one that will be sure to put the ship out of action. This brings us to the second principle.

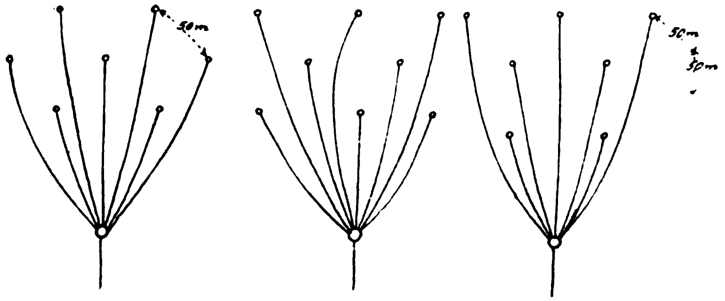
2. The mine must be capable of fatally injuring a ship. If we attempt to satisfy this requirement in any but an empirical manner we find one of the most difficult problems connected with this subject. Many experiments have been made to determine the pressure necessary to produce a fatal breach, but no completely satisfactory result has been obtained. General Abbot deduces 6500 lbs. per sq. in.; while Lt. Col. Bucknill places the figure at about 12,000 lbs.; and other authorities have arrived at still different results. Incidentally, most of the available data refers to experiments made against old fashioned vessels. Another great difficulty arises from the fact that no formulæ have ever been conclusively established that will enable us to predict the pressure that will result from a given charge under known conditions. General Abbot made many experiments to determine this, but, as before stated, his deductions are not accepted without question to-day. The following table, however, summarizing some of his experiments, seems to be accepted in our service.

	Max. destructive radius, ft.		Minimum
Guncotton, lbs.	Horizontal	Vertical	submergence, feet.
100	14.7	17.3	3
200	20.5	24.1	3

This table is probably close to the truth; at least, it is near enough to afford us a basis upon which to work. After weighing the multitudinous other considerations entering the problem, such as interaction between the mines, cost of mine cases and other material, depressing effect of tides, etc., suppose that we decide that 100 lbs. is the least amount of explosive we shall want to put in any of our mines. Then we may assume, if we accept the above table, that if we can explode our mine within 15 feet of the target our second principle will be satisfied.

3. No ship should be able to enter the harbor against our will without coming within the destructive radius of at least one mine. It seems generally conceded that for harbor work the logical arrangement of mines is in one or more lines. Of course for fleet mining or for some special purpose it may be advisable to plant mines in irregular groups. Now if we assume a line of mines across a channel, the "mine block"

system of Bucknill, and take 75 feet to be the beam of the smallest vessel we desire to attack, we have 75 + 2 (14.7) = 104.4, or, say, 100 feet as the interval at which we should plant our mines. Considering the fact that the beam of the latest battleships runs in the neighborhood of 90 feet, this value for our interval should more than cover any accidental



French

1415

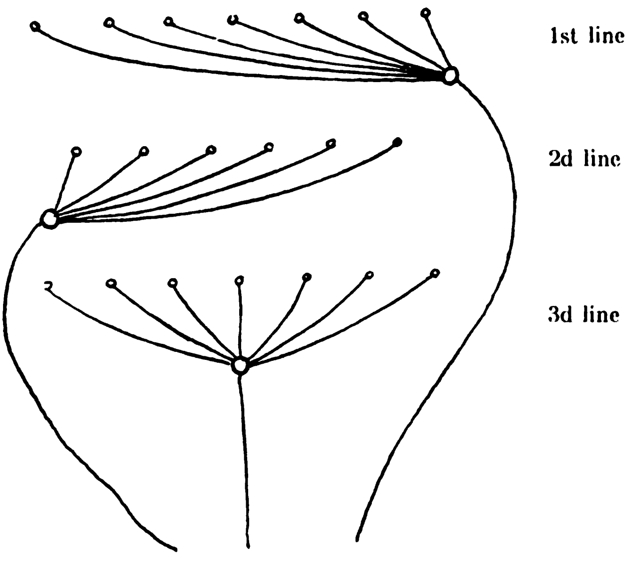


FIG. 12.

1416

irregularities in planting. A little consideration of the probabilities in this case will show that the chances for automatic firing, should such be desired, are very good, especially as it is not always necessary for a ship actually to strike a mine in order to give the signal at the casemate.

A natural deduction from the preceding would be to require more than one line of mines across the channel; otherwise the enemy might feel justified in sending a few worthless hulks against the line, explode several mines and thus leave a clear passage for his fighting ships. Some of the various schemes that have been utilized in laying out a mine field are shown in Fig. 12. It seems to be accepted at present that the single line is the best formation. It is easy to plant, leads to simplicity in the matter of junction boxes, etc., is cheaper than many of the other arrangements and is probably just as efficient as the most complicated. Text books enunciate the principle that there should be at least three lines across a channel.

It is deemed proper to mention here a few of the practical difficulties in attempting to observe this third principle. First let us consider the effect of the tide. In some localities it runs so swiftly that submarine mining is simply impossible, because the mine cases are borne so far below the surface that their explosion would have but little effect upon a hostile ship. Likewise, they may be swayed so far away from their plotted positions as to affect materially the accuracy of firing. A swift current has other disadvantageous effects: the anchors and cables are apt to be buried so completely that they cannot be recovered, and the mooring ropes are liable to be twisted off by the effects of eddies. A chain heavy enough to prevent this rupture by twisting would necessitate a much larger case to secure the required reserve buoyancy. This larger case would offer a larger surface upon which the tidal currents could act, thus resulting in greater twisting and depressing effects, and so on, *ad infinitum*. In passing, it may be well to recall the fact that of all receptacles of a given capacity, the sphere possesses the least surface; hence a spherical mine case is lighter than any other form and presents less surface for the currents to work upon.

Many schemes have been advanced to prevent the tide from depressing a mine, but so far no practical success has been obtained. Most of these schemes involve the use of vane or fin attachments to the mine case; but practically their sole effect seems to be to hasten the time when the mooring rope is twisted apart. In shoal water, large cases anchored close to the bottom could be used; but in deep water this could not be done unless we used mines so large that they could not be handled with the dispatch that is now considered essential. One way around this most difficult obstacle would be to utilize

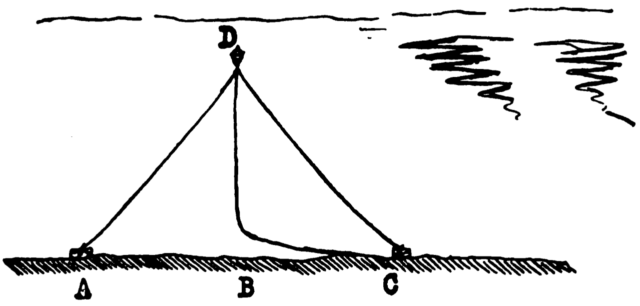


FIG. 13. 1417

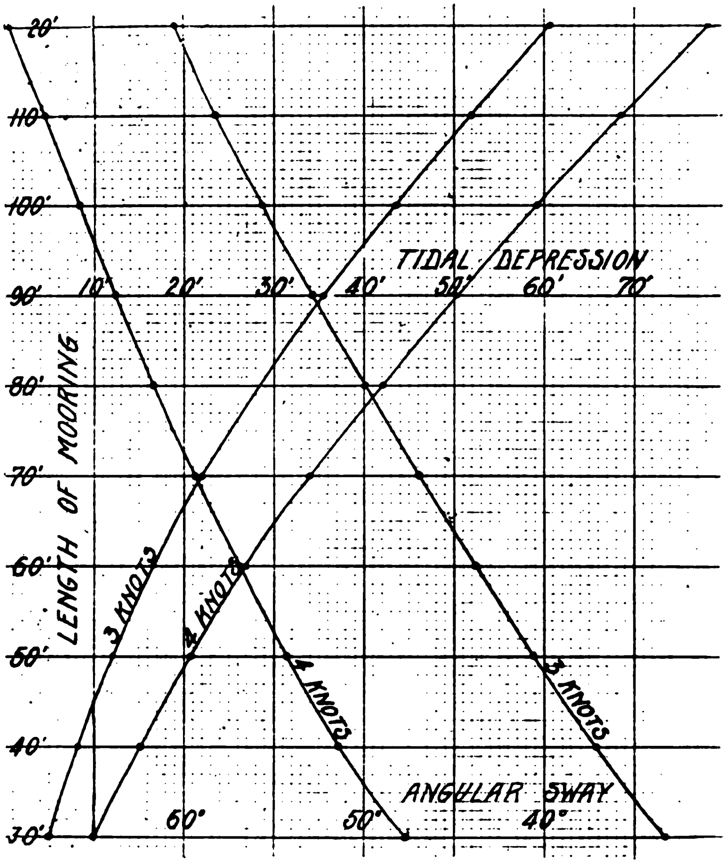


FIG. 14. 1418

Effect of tide on 32-inch case. Abbot's formulæ.

the old fashioned system of double moorings, one form of which is shown in Fig. 13. This system is said to have been in actual use in the British service at one time, though naturally, at that time, there were "certain practical difficulties" in handling it. But, with our present equipment and in cases where the distance A-C does not exceed 130 feet, there should be little trouble in planting such a combination, especially if our anchors would go straight to the bottom instead of "scaling" off to one side or the other, a point which will be taken up later.

In order to show the necessity for some scheme of neutralizing the depressing effect of currents, attention is invited to Fig. 14. The curves are calculated from General Abbot's formulæ, there being no better data at hand. Now, basing our calculations on these curves, let us see how the scheme shown in Fig. 13 will work out (in theory).

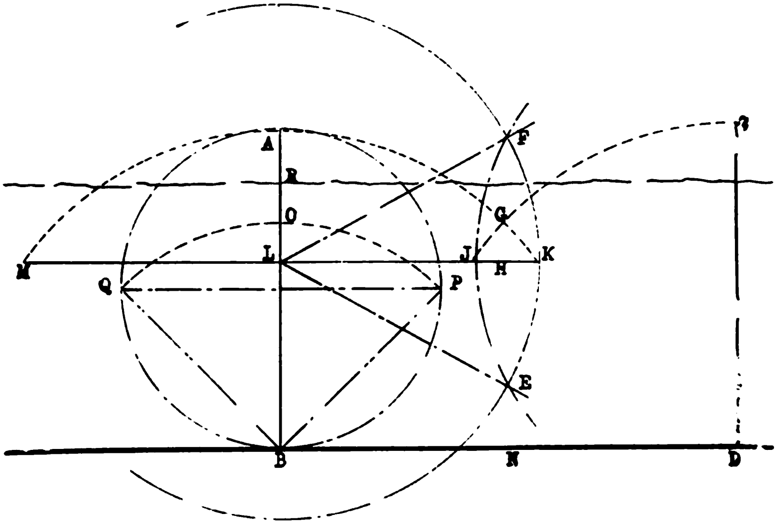


FIG. 15.

Assume, in Fig. 15, BR = depth of water; BR − GN = 10 ft. = submergence desired; BN = ND = NG = 65 ft = ½ the distance between the forward and the after davits. Then BA = DC = BG = DG = 92 ft. = length of mooring. Now a mine with a 92 ft. mooring rope, subjected to a 3-knot tide would be depressed 37 feet. Hence, 92 − 37 = 55 = HN, and the locus of the mine for this tidal velocity is the plane whose vertical projection is the line JK and whose horizontal projection is the lenticular surface FKEJ, the exact position of the mine depending mainly upon the tide. If the flood tide is supposed to flow from M to K at a maximum velocity of three knots, the mine under these conditions will be very close to K. During the strongest of the ebb the mine will be about at J, and at slack water at G. GH = 10 ft. and JK = 18 ft.; hence it is seen that this mine will vary only 10 feet in submergence and (assuming no cross-currents) but three yards from its plotted position. The most disadvantageous cross-current might increase this to 11 yards (½ the distance EF). Of course, the case for this method could be shown in a much more favorable light, compared with our present system, by assuming a depth of water of 150 feet or so, by so cutting our mooring ropes and so spreading our anchors that the angle ABG would equal the angle through which the mine is swayed by the tide. In such a case it is evident that the mine would remain in the same position regardless of the tide. By contrast let us consider the mine OB, planted under the above conditions according to our present system. During flood tide it would be at P, during ebb, at Q; and at other times it would be somewhere on the surface of the spherical segment QOP. Thus it is seen that this mine may vary its location over 28 yards and its submergence by 18 feet; therefore in its most disadvantageous position it would be 14 yards from its plotted position, and be submerged 38 feet.

It is easily seen from the above that to frame a mining project for a harbor where there is a fast current is a rather difficult proposition. That some of our harbors have such currents is seen from the following examples, taken from the Coast Pilots published by the Coast and Geodetic Survey; Portsmouth, 2½-6 miles; Narrows, N. Y. H., 2.3 miles; Ambrose Channel, 2.2 miles.

There is still another phase of the tide question that bears investigation, and that is its effect in altering the submergence of the mine through its rise and fall, considered apart from its translational effect. If we assume a tidal range of 10 feet and have our mines submerged 10 feet at M. L. W., they will evidently be submerged 20 feet at high water. This in itself would not be excessive, but when considered in connection with the other effect of the tide, the situation often becomes intolerable. For instance, should the tide be at 10 feet and have a depressing effect of 30 feet, we should have a total submergence of 50 feet, which is evidently excessive. No regulators have yet been invented that will overcome in a practical manner the effect of this change in tidal level. One way to obviate the difficulty is to plant each successive line of mines with a different submergence. For example, assuming a tidal range of 10 feet and three lines of mines. suppose the outer line to be given a submergence of 10 feet at M. L. W., the next 5 feet and the inner line to be planted just under the surface. It is apparent that all mines would be invisible, except perhaps the inner line for a few minutes at extreme low water. At the time of the strongest ebb the state of affairs would be approximately as shown in Fig. 16 in which the figures above each mine show the submergence on the supposition that the water is 40 feet deep at M. L. W. and that the maximum tidal velocity of three knots occurs at the half-stage. It will be noted that all of these mines are in excellent positions as far as submergence is concerned, and although this happens to be a favorable case, the logical application of the underlying principle will enable us to solve many problems which would otherwise be difficult

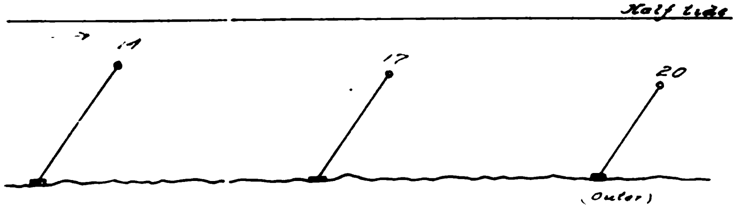


FIG. 16. 1420

In leaving the subject of tidal influence the writer would like to emphasize these points:

(a) Channels having deep water and swift currents cannot be mined by a single mooring system.

(b) If the double mooring system can be made feasible it will prevent mooring ropes from twisting off, and will permit mining some channels otherwise impracticable.

(c) A submergence of 10 feet should not be made mandatory. It is the belief of many officers whose experience entitles their opinions to respect that, considering the probable targets, the actual submergence at the instant of explosion should be at least 20 feet.

Formerly the observance of the third principle was beset with another difficulty, arising from the fact that the explosives used were in some cases quite susceptible of "sympathetic detonation." If the mines were placed too close together the explosion of one might set off the whole line. An interval of 100 feet was concluded to be safe in the case of our mines using 100 lbs. of wet guncotton, and it was found that our cases would easily withstand this stress. If using trinitrotoluol, which is extremely sluggish, this interval could be reduced if desired, but under the circumstances this distance is considered to be sufficiently small.

Whenever it becomes necessary to mine our harbors, we shall find in the majority of cases that it is not permissible to block the entrance completely; a passage must be left open for the use of our own or neutral vessels. In countries where the mines are left down for long periods this object is sometimes attained by hitching the mines close to the bottom by means of extra anchors and "explosive links." When the occasion demands it, these links are fired from the shore and the mines rise to their proper position in the water. Until the link is exploded the mine is too deeply submerged to interfere with traffic and so no unmined lane is necessary. In cases where the passageway must be provided for, it should be so laid out that vessels can be brought past the mines without danger, but this must not be so easy that anybody could do it. The lane should be rather tortuous, and pilots should be at hand to take the vessels through by means of ranges or bearings known only to themselves and to the proper military authorities. Of course, no vessel should be permitted to pass without taking on a pilot.

4. The mine installation must be properly protected. In the first place, it is axiomatic that the mine fields must be well covered by rapid fire guns. When a field is not so protected, it is but a question of time before an enterprising enemy can destroy the whole field. The location of the field is always a local problem, and hence the particular guns which should be assigned to the defense thereof can be determined only after a thorough study of local conditions. As a matter of opinion, it is believed that when the mines are more than about 3000 yards from the batteries our 3-inch R. F. G. is too feeble to be of much use; a much better idea would be to use a 6-inch shrapnel or "universal projectile," provided an efficient time fuse could be evolved. The probable targets, judging from the trend of foreign activities, would be vessels of the "steam trawler" type, it being almost a certainty that such craft as launches and small boats could do no damage to any of our

mine fields. Any person who has had much experience with our mines knows how hard it is to recover one except in the regulation manner, and likewise how difficult it is in some of our harbors to recover a cable even when its position is accurately known. Without bosses on mine cases, successful "sweeping" is impossible in theory as well as in practice. In any event, chances of damage by sweeping, other than a possible change of position of the mine, are extremely slight.

The position finding stations and casemate must be protected and should be most carefully concealed. The ideal condition would be to have them so well concealed that even if the enemy should capture the fortifications he would still be unable to locate the mine installation. Even if the guns of a fort should be put out of commission, the enemy would not enter until he was reasonably sure to suffer no damage from mines. Some authorities advocate mining the casemate and the P. F. stations, so that in event of their impending capture by the enemy they can be blown up, thus postponing the location of the mine fields.

It goes without saying that the mine command should be included in the plans to frustrate attacks from the land side, but a discussion of this point is believed to be outside the province of this article.

5. The project must be easy to handle. This principle covers a vast field: it requires an installation that can be planted quickly and easily; it requires flexibility in the P. F. system; it must be so simple in all its operations that the enlisted man can understand it. The use of "automatic" anchors, which give a predetermined submergence of the mine, even when the depth of the water is unknown, is one of the direct results of this principle. To show how it is carried out in the electrical part of the system would require more space than is available. A good example of a P. F. system that violates this principle is found in the old system of firing and converging arcs formerly used by the British Engineers and still used by some countries. (See Fig. 17.) Here A is the "converging" and B the "firing" station with their respective telescopes. Now if one of the mines were accidentally planted out of line (A to F), it would be necessary to raise and replant it in the proper line. It is evident that this state of affairs might seriously retard the planting of the field. By contrast, consider our P. F. system which is unaffected by the positions of the mines so long as they fall on the plotting board.

This principle would require an efficient and labor-saving lay-out of the loading rooms, storerooms, cable tanks, wharves and other structures. To observe it strictly one should study modern "business efficiency," eliminating all useless movements and operations and so altering the surrounding conditions that there shall be a minimum of wasted work. Our present system observes this principle fairly well, but there are many cases in which local conditions could be improved. Our means of planting mines, though good in quality, are deficient in quantity.

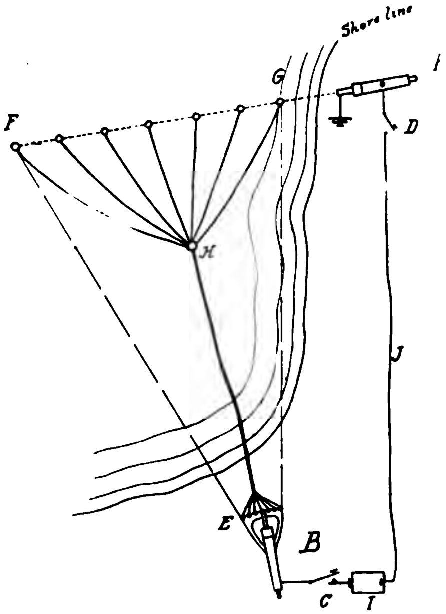


FIG. 17. 1121

There are several other principles which we must observe if we wish to produce an efficient system of submarine mining, but lack of space prevents a discussion of them. It is well understood, of course, that mines should be safe in planting and raising, etc., and should conform to the requirements laid down in the laws of war.

IV. RELATION TO OTHER ELEMENTS OF THE DEFENSE

Having previously shown that the mine defense of a harbor is not self-sufficient but must work cooperatively with the gun defense, we shall here limit ourselves to a few remarks concerning the personnel of the mine command. There seems to be little doubt in the minds of careful students of the problem that the fixed defenses of our fortified harbors should be in the hands of the Army and that, in our case at least, the Coast Artillery Corps is the proper arm for handling the mine defense. To be sure, England has abandoned her controlled mine system and has given to her Navy the duty of all harbor defense mining. This the Navy is supposed to accomplish by means of their automatic mines. A cursory examination reveals the peculiar conditions that must have led to this step. But the same conditions do not obtain in our case, and it would be the height of folly to accept such action as a precedent that we should follow. We probably have the best mine defense in the world, that is, the best suited to our particular needs, and it is therefore imperative that we shun foreign ideas, unless they prove to be better adapted to our case than our own.

If the Coast Artillery Corps is to man the mine defenses, it is essential that the organizations assigned to this work shall differ as little as possible from the other companies which are assigned exclusively to gun work. But, although the organization of the two kinds of companies should be approximately the same, they should be handled differently. If a mine company is made to do as much purely artillery work as the other companies and its mine work in addition, it will be overloaded. This will cause it to be shunned by valuable men and will foster discontent in the company. Mining is probably the hardest physical work that falls to the lot of the artilleryman; many of its operations are wet, dirty, and disagreeable. It is therefore important to avoid any unintentional discrimination against mine companies, and the total work done by them should be about equal to that required of other companies.

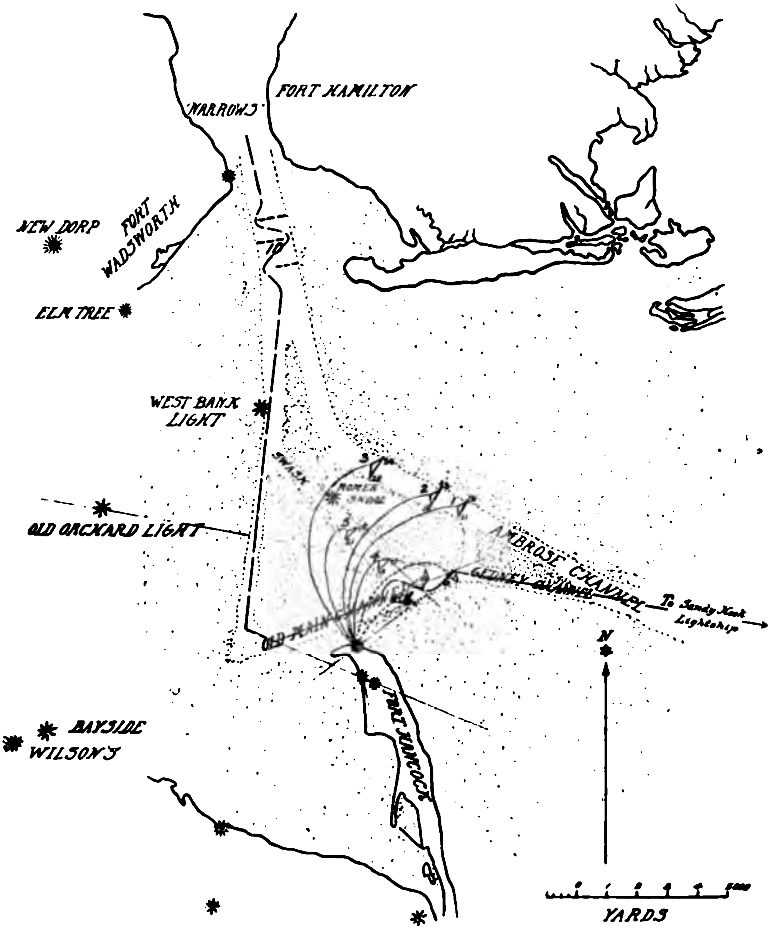
When we consider that, in addition to manning a R. F. battery and holding target practice thereat, a mine company must also receive instruction during the outdoor period in siege gun work, small arms target practice, mining in all its phases and under all conditions, and infantry field work, besides spending several weeks in "concealment of fortifications," the magnitude of the task imposed seems well-nigh appalling. However, a skilful allotment of the available time will do much to lighten the load. This should be done more on the "task" principle that is so prevalent in modern "business efficiency" methods. That is, as soon as a company shows the desired proficiency in one phase of its duties, let it advance to the next "task"—of becoming expert in some other line of endeavor. Nothing is gained by continuing a drill beyond the stage where the men instinctively execute the correct movements in a proper manner; that is, after the drill becomes "automatic." On the other hand, nothing is more detrimental to the spirit of the men than to keep them too long at any drill that lacks interesting or new features. Both of these facts may be illustrated by saying that it is easier to "overtrain" a gun crew than a football team. Most officers assigned to R. F. batteries are driven to their wits' ends devising new features to vary the dull monotony of drill at their batteries and thus keep alive the interest of their men. This constitutes one of the occasions where a mine company should be handled differently from a gun company. Ordinarily, if a company cannot hit with R. F. guns after a month of drill, they never will, and any postponement of target practice beyond this time will result only in causing the battery to "go stale." By utilizing the task idea, such detrimental effects could often be avoided, and by an occasional "review" of the various drills on suitable occasions, the maintenance of the desired degree of proficiency could be insured.

A point where some of the mine companies labor under a disadvantage, arises as a result of the present method of maintaining the planting detachments aboard our mine planters. Under existing regulations these men are taken from one or more mine companies and placed on detached service while on the planter. These detachments should be separate organizations under the commanding officer of the planter, or the companies furnishing them should be allowed an increase of authorized strength of 1 sergeant, 2 corporals, 1 cook, and 12 privates to cover these permanent absentees. The present system is more or less of a hardship upon both the detachment and the parent company, and sometimes this hardship is rather severe.

Our "chain of command" as at present constituted seems well adapted to its purpose. It is but logical to have a "mine command" with rank equivalent to that of the fire commands, all united under the battle commander. However, when there are two or more companies in a mine command the mine commander should not be one of the company officers and should be property officer.

V. TACTICS

There is, perhaps, no better way to show the tactics of submarine mining than to draw up a project for one of our fortified harbors, thus exemplifying the practical application. For this purpose let us choose New York, our most important port. But, in the beginning, let it be understood that the following scheme of defense bears no relation whatever to the authorized project for this harbor; for, although it is well to advertise the efficiency of our mines, it is poor policy to announce where they will be found.



Course of ship shown by broken lines—

Fig. 18.

In formulating our project let us first select our "refuge channel." It is patent that such a channel is imperative in this case, the Brooklyn Navy Yard and New York's shipping both demanding it. From an examination of a New York harbor chart we see that there are three principal channels that must be considered. See Fig. 18. The most important is Ambrose Channel, dredged to a depth of 40 feet and a width of 2000 feet. It runs over the bar and between shoals whose depth in feet at various places is shown by figures in the cut. At its nearest point the center of this channel is, from the guns at Fort Hancock, a distance too great for the effective use of 3-inch guns. Gedney Channel has a depth of 30 feet at M. L. W. and, like all the other channels, is bordered by shoals. It leads into the Swash and the Main Channels. South and False Hook Channels lead into it from the South; but they are not practicable throughout for vessels of the largest size, and hence are not shown in the cut. The Swash Channel is narrow, leads close to the edge of Romer Shoal and has a depth of 25-29 feet, but there are several humps with only 22 feet over them. Main Channel leads from Gedney Channel between shoals by a circuitous route to The Narrows. It was formerly the main route to and from the Upper Bay, but has been superseded by Ambrose Channel. A glance at the chart will show that it would be suicidal for a vessel to attempt to force an entrance by means of this channel. It has sufficient water to take any vessel desiring to enter the port. Let us therefore decide upon the Main Channel as the one to be kept open for the use of friendly shipping, and close up all the others by means of "mine blocks."

Having decided that Ambrose and the Swash Channels are to be closed, let us decide upon the location of our mine fields. They are at such ranges that they must be protected by 6-inch guns. By plotting the fields of fire of these guns we determine the limits between which we should endeavor to locate our mines. One line of mines will extend completely across Ambrose Channel, and unless a ship leaves the channel she must inevitably come within the destructive radius of one of these mines. After careful consideration of the chart, we plot the positions of Groups 1 and 2, their flanks resting on dangerous shoals. As these groups will be out of sight in foggy or rainy weather, we place another group, No. 3, in that part of the channel nearest to Romer Shoal Light and decide to use the latter as an auxiliary observing station.

In the Swash Channel we place two lines of mines. If their location be skilfully chosen, groups of seven mines each can be made to do the work, as parts of the channel have a width of only 200 yards for vessels drawing more than 20 feet. No. 5 group could easily be planted closer to Romer Light, where its right and left flanks would rest on shoals of 21 and 14 feet respectively. This would facilitate observation in case of fog, etc., but would place our auxiliary observers in a very dangerous position. We would therefore probably keep Groups 4 and 5 close to the southern end of the channel, keeping Romer Shoal Light further away from our line of fire.

In the case of the Main Channel, although we wish to avoid hindering friendly traffic, we also wish to prevent the possibility of a "run-by," and we therefore decide to mine this channel in such a way as to fulfil these two conflicting requirements. In order to introduce turns into the channel, and yet make the course smooth enough to be followed by the big liners that would have to navigate the course, let us place a group of 7 mines near the outer end of the Main Channel where they will block all but about 200 yards of the fairway. About three quarters of a mile inside this line let us place another group of 7 mines on the opposite or northern edge of the channel, placing a third group, No. 8, also of 7 mines, about three quarters of a mile inside Group No. 7 and in the southern half of the channel. (This is not the best place for Group No. 8, the water averaging 60 feet deep; but, for the sake of an illustration, this position will be selected.) In case especial security is desired, three more groups could be planted from Fort Wadsworth or Fort Hamilton, as shown at 10 in Fig. 18. These groups must be planted far enough to the southward to escape the worst effects of The Narrows current, and even then special measures will probably be found necessary.

For navigating the Main Channel we should place an electric buoy in the channel near the edge of the shoal north of Group No. 6. The electric lighting mechanism should be controlled from Fort Hancock and should be kept out of commission except in emergencies. A case can readily be imagined where it would be highly important to be able to take a vessel in or out of the harbor at night, but one should never be taken through on a rainy or foggy night. After leaving this buoy close on the starboard hand, the vessel should steer straight for the "North Hook Beacon," the northernmost light on Sandy Hook, until she arrives on the Swash Channel Range (Elm Tree and New Dorp Beacons in range bearing N. W. ½ N.). Here the course should be changed towards another electric buoy on the edge of the channel north of Group No. 8, passing it close on the starboard hand. After this the ship should change her course to the southward until on the Main Channel Range, Wilson's, and Bayside Beacons in range, bearing about W. by S. ¾ S. From here the navigating can be done on ranges as shown in Fig. 18. There would be no harm in keeping these range lights in commission even during the presence of an enemy's fleet; for, if the latter attempted to force the channel by means of steaming on the usual ranges, it is probable that all three lines of mines would be encountered. Ordinary navigation buoys would be removed and unnecessary lights extinguished. If additional mines are planted at 10, it will be necessary to establish further aids to navigation at that point. Outgoing vessels should be required to take on their pilot at Quarantine; incoming ships could secure theirs from the Sandy Hook Lightship or, in its absence, could send a wireless call for one to be furnished from Sandy Hook, the latter being preferable. Regulations covering these matters would have to be published to the shipping interests and the cooperation of the harbor-master and other officials obtained.

Having now determined the number of groups we shall need, we must decide upon the class and size of mine that will best satisfy our problem. Mines proper may be classified as follows:

Position	Action	Method of Fire	Variations	Remarks
I. Ground mines	A Automatic	1. Mechanical.	. . .	e.g. "Devil Circumventor"
		2. Chemical 3. Electrical	. . .	Rare.
	B Controlled	1. Contact	Pendulum Relays Ball and seat	All electrical. Circuit-closer buoy necessary for 1 and 2. Used by various nations, notably the French.
		2. Delayed Contact		
		3. Observation		
		4. Combination	a. Variable after planting. b. Adjusted before planting.	
II. Buoyant mines	A Automatic	1. Mechanical	. . .	Elia's Mine.
		2. Chemical	. . . .	Jacobi's Mine.
		3. Electrical	. . . .	U. S. N. Mines.
	B Controlled	1. Contact	Pendulum Relays Ball and seat	All electrical, with or without circuit-closer buoys.
		2. Delayed Contact		
		3. Observation		
		4. Combination	a. Variable after planting. b. Adjusted before planting.	

The tendency in our service is to discard the ground mine. In cases where we desire to plant a mine on the bottom we simply shackle a buoyant mine direct to the anchor. The ground mine case is comparatively cheap, but weighs about four times as much as a buoyant case of similar capacity and is therefore unwieldly. Let us assume that we use only our buoyant cases. To find the proper size of mine case, let us see if our 32-inch case will not suffice. Suppose we have determined that the maximum velocity of the current is 2.2 miles per hour and that 7 feet represents extreme high tide above M. L. W. We then calculate the following table, where *D* represents the average depth of water as found by soundings or on the chart; *s* is the submergence at M. L. W. with no current; *l* is the length of the mooring rope; *x*, the depression of the case due to the maximum tidal velocity; and *s'*, the theoretical submergence at 2 3 extreme high tide and with maximum current. All distances are in feet, *s'* being taken to the nearest foot.

Group No.	D	s	l	x	s'
1	40	20	15	1	26
2	40	15	20	1.5	21
3	40	10	25	2	17
4	30	15	10	.5	20
5	30	10	15	1	16
6	31	10	16	1	16
7	28	15	8	.5	20
8	60	15	40	4	21

From the above table we see that it is entirely practicable to mine this entrance by utilizing only 32-inch cases. The submergences shown in the above table under *s* are entirely arbitrary and could be varied considerably according to the desires of the proper authorities. As previously indicated, the writer is one of those believing in somewhat greater submergences than those we use at present, and hence the above values for *s'* might be held to be excessive. However, if we consider the construction of modern battleships, the extent of the armored belt below the waterline and the placing of coal bunkers where they will tend to frustrate torpedo attacks, it is believed that the advisability of these increases in submergence will be acknowledged. In some of the above groups a better installation might be secured by using larger cases; and, notably in No. 7, ground mines could be used if desired, especially if 300 pounds of explosive were used.

Let us now select the positions of our various shore stations, including the P. F. stations, casemate, etc. In determining the locations of the position finding stations the requirements to be considered are given in Section I, *Artillery*

Notes No. 11. In placing our casemate, its protection and concealment are of primary importance, but several other items must receive due attention. Some of these are: habitability, accessibility, proximity to mine fields, best location for leading cables into the water, possibility of damage to cables by anchored vessels, availability of post power, and, not least, the possibility of using some emplacement or similar structure for protection. It is a great convenience if the mine structures are together; but, as mere convenience is but a minor benefit, having them together should not receive undue weight. The loading room, store rooms, boathouses, and tanks should all be as close to the mining docks as other more important considerations will permit. It is readily seen, therefore, that the best location of these buildings is another local problem which must be solved separately for each project. The best solution can be arrived at only after an exhaustive investigation of local conditions, but it amply repays the expenditure of time and thought. In applying the above remarks to the concrete example in hand it is impossible, on account of the diminutive size of Fig. 18, to show how we should give to each requirement its proper weight, other than to reiterate the advisability of occupying Romer Shoal Light as an auxiliary observing station.

We are now in a position to draw up our requisition for matériel. We know how many mines we need, which will enable us to ascertain the quantities of tools and supplies desired. We can see now the number of operating boards (one spare) that will be needed, and can therefore design our casemate and know what equipment will be required therein. By measurements from the chart we determine the amount of cable desired, which gives us a basis for designing our cable tanks. The general plan and size of the project enables us to judge of the planting equipment necessary.

We may now turn our attention to the matter of defense for the mine command.

From a consideration of the distances of the several groups from Fort Hancock, we can see the urgent necessity for 6-inch guns. There should be at least four guns of this caliber permanently assigned to the mine command. As it is probable that the armament of Fort Hancock was calculated and installed when the Main Channel was the most important, it follows that there will be a sufficient number of 3-inch guns properly to protect Groups Nos. 6, 7, and 8. At least eight

3-inch guns should also form a part of the mine command for this purpose, though changing circumstances may materially affect this calculation. This estimate of a proper gun defense is purely a matter of opinion and may be considered as inadequate or as excessive depending upon the views of the reader. As a matter of fact, the armament at Fort Hancock that is applicable to mine defense may or may not be identical with the estimate here shown. If not, it is not proof conclusive that this estimate is erroneous: it may pertain to an entirely different project, or it may simply tend to show that conditions have changed since the meetings of the Taft and other boards, and that ideas have also changed.

A point bearing upon the question of armament that should be considered in this connection is the fact that in the neighborhood of Sandy Hook the ocean floor is of a very shifty nature. It has been reported that a certain multiple cable run out in this vicinity was so buried in sand after being in position for a few months that it was impossible to recover it by grappling, thus necessitating the laborious operation of recovering it from the shore end. If this be so, and it is believed to be to a less degree, in many of our harbors, it is evident that there need be little fear of an enemy damaging our installations, especially this one, through securing possession of the cables. Practically the only way in which the enemy could hurt the project would be in getting hold of the mines themselves, and this would be very hard to do.

In foggy or rainy weather auxiliary vessels are necessary to the efficiency of the mine command. These are for use as pickets or scouts and should be speedy vessels. Destroyers or torpedo boats that have outlived their efficiency in the fleet could be utilized for this purpose whenever available. In such a port as New York there should be no difficulty in securing some of the fast power boats that are so numerous. Other boats of more seaworthy types could be obtained for use in rough weather or in harbors where such qualtites are essential.

CONCLUSION

To the layman submarine mining is perhaps the vaguest and least understood of all the arts of war. Even the experienced officer is sometimes embarrassed for lack of information concerning some technical point of the system. The subject contains some of the most sedulously concealed and zealously guarded of all "state secrets," and for this reason it is extremely difficult for one to obtain up-to-date data concerning foreign systems. The writer has labored under these disadvantages, and as an inevitable result has perhaps given too prominent a place to matters which are but expressions of personal opinion. Wherever these opinions and deductions are incorrect, it is hoped and believed that their fallacies will be promptly and effectually exposed, to the end that it may tend to still further improve our present excellent system.

JOINT ARMY AND NAVY EXERCISES*

By Colonel RICHMOND P. DAVIS, Coast Artillery Corps

Joint Army and Navy exercises were inaugurated in 1900 and held practically on alternate years until 1905; then there was a lapse until 1913. The earlier exercises were too frequent; the interval between the last two, much too great.

No doubt the two contributory causes to the discontinuance after 1905 were their frequency and the failure of both parties to appreciate the real worth of such maneuvers, this latter in turn being due in great measure to the fact that, on the part of the Artillery, for most officers concerned, the exercises were simply prolonged drills, and, on the part of the Navy, little more than simply sailing in as the spirit moved. Furthermore, so far as the Coast Artillery was concerned, the fire-control installation in many instances was more or less a makeshift, nearly everything, in fact, being embryonic.

I further attribute the lapse of interest in the exercises to the failure of a great many coast artillerymen to appreciate the necessity for a comprehensive study of the naval side of attack on fortifications, and to the feeling on the part of many naval officers that their primary function is not attacking fortifications, an attack upon effective fortifications being wholly out of the question. Be that as it may, it is nevertheless true that one of the most important duties of the Coast Artillery is the study of the naval side of the problem, and that there is no telling when the Navy may be called upon to attack fortifications; therefore each should study the other side of the page and occasionally get together in combined practical work for mutual benefit.

It has been stated earlier that the coast artilleryman in general has failed to make that study of naval relation to fortifications necessary for most effective results, and it may be stated with still greater assurance that he has given more attention to it than the average naval officer to the reverse problem—this for the reason stated above, that naval men in general consider fortification attack a secondary and remote rôle.

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* This article was prepared by Colonel Richmond P. Davis, in command of the Coast Defenses of Long Island Sound, at the request of the Editor.

I am not afflicted with "navalphobia"; but I do assert that the study of the naval side of an attack on fortifications is of vital importance in every stage of coast artillery work, from the location of a defensive position to the training of the latest recruit, and that combined exercises are an important factor in such study. However, lest we forget, a word of warning is due as to the innate tendency of the human individual to become obsessed with an idea and lose all sense of proportion.

This naval study may be divided into two parts—

(a) Naval vessels.
(b) Naval tactics.

It is in connection with (b) that joint exercises are a *sine qua non.* They are very far reaching for the coast artilleryman, enabling him to test his men, his system, and some of his matériel, with actual ships in the battle area. I started to say "for targets," instead of "in the battle area"; and herein is a sadness, that we have not arrived at the point where an actual ship has been used for a target by coast artillery. But, even then, conclusions would not be really definite, as there would be absent the firing by the ship.

Proving ground firings at armor and at ship sections and at fort parapets are well enough in their way; but what I want to see is firing by the navy at real fortifications with its batteries, stations, and searchlights, and firing at a real ship by the batteries of a coast artillery fortification.

I am digressing sadly; but half an hour of such work would be worth a dozen years talk, and, I feel confident, would settle some mooted questions on which I have heard opinions of some very representative members of both services run riot.

For joint exercises there will be necessary always two periods, namely—

I. Preparation.
II. Activity.

I. PERIOD OF PREPARATION

The first period will be necessary, since it may be stated with absolute certainty that the day will never arrive when all the armament of any coast defense will be complete and fully manned; therefore in preparation for a naval attack (simulated or otherwise) there will be work in connection with the equipment and with the adjustment of tactical commanders and troops to their new situations. In this connection, it may be stated that for our latest exercises twelve batteries had to be equipped in some particulars for fire-control and the personnel had to be increased ninety per cent, only one of the eleven higher tactical commanders occupying his ordinary peace station. Thus it is seen that the preparation period was indeed an important one, and, it may be stated positively, always will be.

In order that all concerned might derive full benefit from the exercises as well as perform their ordinary tactical duties, the problems given below were issued.

These problems served their purpose well, and, in conjunction with the preparation drills, enabled the command to be well qualified for the period of activity. The desirability of the problems is illustrated by queries from several officers as to whether they were expected to write naval orders or to know how the Navy would attack.

The problems and their solutions follow:

PROBLEM NO. 1

Coast Defenses of Long Island Sound

July-August, 1913

Each officer of the command will solve the following problem for a conference before July 28th.

GENERAL SITUATION

On account of the strained relations between Blue and Orange, the Blue Atlantic Fleet arrived at Honolulu on June 20, 1913.

On July 15th, due to complications in Green territory, the Black Ambassador left Washington.

On July 16th there passed out of the English Channel headed west, with instructions to establish a base inside Long Island Sound, a Black fleet composed of:

12	Battleships
1	Monitor
1	Mine-layer
3	Cruisers
20	Destroyers
10	Submarines
	Train

REQUIRED

(a) Organization of the Black Fleet.

(b) Estimate of the situation.

(c) Plan of action of the Black Fleet.

(d) Orders for the various operations which it will be necessary for Admiral A to undertake.

(e) Probable formation of the fleet for a run-by.

NOTE: (1) Fort Mansfield channel has been blocked against all craft.

(2) It is assumed that these defenses are the objective of the black fleet.

AN APPROVED SOLUTION

(a) ORGANIZATION OF THE BLACK FLEET

Admiral A Commanding

Independent flagship—Capt. A.
Dispatch-boat, destroyer—Lieut. A.

1st Division

Admiral B Commanding

A flag, Capt. ———
B Capt.———
C Capt.———
D Capt. ———

2nd Division

Admiral C Commanding

E flag, Capt.———
F Capt.———
G Capt.———
H Capt.———

3rd Division

Admiral D Commanding

J flag, Capt.———
K Capt.———
L Capt.———

Destroyers

Cruiser, flag-ship, Captain B, Commanding destroyer flotilla

Group 1, Commander B
- A, flag, Comdr. B.
- B, Lt. Comdr.
- C, Lt. Comdr.
- D, Lt. Comdr.

Group 2, Commander C
- E, flag, Comdr. C.
- F, Lt. Comdr.
- G, Lt. Comdr.
- H, Lt. Comdr.

Group 3, Commander D
- I, flag, Comdr. D.
- K, Lt. Comdr.
- L, Lt. Comdr.
- M, Lt. Comdr.

Group 4, Commander E
- N, flag, Comdr. E
- O, Lt. Comdr.
- P, Lt. Comdr.
- Q, Lt. Comdr.

Group 5, Commander F
- R, flag, Comdr. F.
- S, Lt. Comdr.
- T, Lt. Comdr.

Submarines

Monitor, parent ship, Commander G, Commanding submarine flotilla

Group 1, Lieut. A
- A, flag, Lt. A.
- B, Ensign.
- C, Ensign.

Group 2, Lieut. B
- F, flag, Lieut. B.
- G, Ensign.
- H, Ensign.

D, Ensign. I, Ensign.
E, Ensign. K, Ensign.

Train

Admiral E Commanding

Cruiser, flag-ship, Capt.——
1 Repair-ship.
1 Mine-layer.
1 Hospital Ship.
3 Supply Ships.
6 Colliers.
Note: 2 Cruisers act as convoys.

(b) ESTIMATE OF THE SITUATION

1. *Mission.*—To reduce the defenses, the element of time not being of great importance.

2. *Enemy's forces.*—The Blue Atlantic Fleet, due to the strained relations between Blue and Orange, is based on Honolulu, where policy requires that it remain. There is no other Blue Fleet that can arrive in these waters for at least six months. The only opposition to be met is that of the Naval Militia, and that of the Coast Defenses of Long Island Sound. The Black General Staff has given Admiral A complete charts of these waters. His information as to the caliber and number of batteries of the primary armament and as to the other elements of the defenses is general in character; but from the importance of the location, the defenses may be assumed as strong, well equipped, and well manned.

3. *Black forces.*—

12 Battleships.
1 Monitor.
1 Mine-layer.
3 Cruisers.
20 Destroyers.
10 Submarines.
Necessary train.

4. *Line of action open.*—Admiral A's charts show him all the advantages and disadvantages of the channels that these defenses are assigned to cover. He knows that the best channel is well covered by guns of large caliber, with certain limitations due to great range. He may well assume that all the channels are now closed by mines. The Fort Mansfield channel is poor and, if open, would only pass light draft vessels. According to the conditions of the problem, it is blocked against all craft, so will not be further considered as of possible use to Admiral A. (However, to insure effective blocking, movable armament would be placed to bear on it.) As stated above, time is not an important element in his work; so, when Admiral A is finally ready to attempt passage, he will know all the essential details of the defenses and may choose the least protected channel.

(c) PLAN OF ACTION

Admiral A decides to base at— —and immediately to institute reconnaissance day and night to determine the location of lights, mines, position finding stations, and nature and location of batteries; this done, to attempt to destroy the stations and lights and to open a channel through the mine field; and, when these items are accomplished, to effect a run-by with part of his fleet on the first favorable night, under cover of the smoke of the destroyers making an attack from both front and rear.

(d) ORDERS

To accomplish the foregoing, the following orders are issued:

Fleet Orders, Off———Island,
No. 1. 2 P. M., 3 Aug., 13

1. We can not pass into Long Island Sound without reducing the defenses. There are no naval supports for the fortifications.

2. Bases will be established at———Island and———Bay. Battleship divisions to———Island, rendezvous A. Destroyers and Submarine Flotilla to———Bay, rendezvous B.

The train to rendezvous B.

Independent flagship and dispatch boat to rendezvous B.

3. Group 1, destroyer flotilla, to picket duty at dusk.

4. Conference of Division and Flotilla Commanders on flagship at 8 P. M.

Dispatch boat from rendezvous A at 7 P. M.

A,
Admiral, Commanding.

To Division and Flotilla Commanders by Signal.

At the conference the Admiral would exhibit his charts, state the information at hand, and give the following order orally, which, if written, would be:

———Bay,
Midnight 3-4, Aug., 1913

1. The enemy has extensive fortifications covering the water area from———to———. Before proceeding further, extensive reconnaissance is necessary. There are guns requiring at least 3000 men for their service, and the harbor is known to be extensively mined.

2. The destroyer and submarine flotillas will proceed at once to reconnoiter search light positions and mine fields, the respective commanding officers assigning to each group specific sections from———to———.

3. The battleship divisions will prepare to establish a blockade, and to search out the fire-control stations and batteries.

The first division will establish the blockade as soon as the mine field is delimited, and will be relieved in turn by the other divisions.

4. The second and third divisions will hold themselves in readiness for a reconnaissance in force, as soon as the outer limit of the mine field is defined.

Admiral———will command the reconnoitering divisions. They will be reenforced by one destroyer group.

5. Messages to the flagship at rendezvous B until further orders.

The division and group commanders will then return to their units and issue the following orally to their respective commanders:

2nd Division's Orders

1. The strength and location of the enemy's batteries and accessories are not known, but from a study of the map would appear to be at———and ———and———.

2. The 2nd and 3rd Divisions will make a reconnaissance in force as soon as the necessary information as to mine fields is obtained.

3. The formation will be———, the flagship leading.

The fleet will be preceded by a destroyer group at 1000 yards.

4. The Divisions will search the sectors———to———and———to ———.

B,
Admiral, Commanding.

The 3rd Division's commander would issue similar orders.

Destroyer Flotilla's Orders

1. The enemy's search-lights and mine fields are probably located as follows:

Rapid fire guns are probably at———and———and———.

2. Groups 2, 3, and 4 will reconnoiter for mines; group 5 for search-lights; no firing under any circumstances.

3. Information to me here at daylight.

A,
Commander

Submarine Flotilla's Orders

(Similar to those for the Destroyer Flotilla.)

(e) PROBABLE FORMATION FOR A RUN-BY

A study of the charts indicates echelon from the right as the best probable formation for a run-by.

PROBLEM 2

SPECIAL SITUATION

The following radiogram was received from the Supervisor, 2nd Naval District:

"A division of Black Scout Cruisers (Classes 11 and 12) was sighted at 4:00, P. M. about 60 miles south by east of Newport, sailing west at top speed."

Required:—

(a) Estimate of the situation.

(b) Orders of the Coast Defense Commander in case the cruisers come in the battle area.

(c) Classes of the cruisers seen.

(d) Track sheets of all targets assigned, with time, range, and any rounds fired indicated on each track.

Battle, fire, and mine commanders to have solution at headquarters at 6:00 P. M., Saturday.

AN APPROVED SOLUTION

(a) ESTIMATE OF THE SITUATION

1. *Mission.*—To prevent the accomplishment of the enemy's purpose.

2. *Enemy's forces.*—The probable mission of the division of scout cruisers is to reconnoiter for a base and incidentally obtain all possible information as to the defenses. The cruisers, no doubt, have orders not to expose themselves and not to enter into an engagement.

The main body is probably not far behind.

3. *Coast defense.*—We must observe the enemy, keep our position concealed, and not permit the enemy either to pass by or approach very close.

4. *Decision.*—To hold all troops in readiness; to man the intermediate and secondary armament; and to operate only the search-lights immediately across the channel.

(b) THE COAST DEFENSE COMMANDER'S ORAL ORDERS TO BATTLE AND FIRE COMMANDERS

1. The enemy's cruisers will be off— —probably by seven o'clock to-day on a reconnoitering expedition.
2. Man your intermediate and secondary guns; hold primary battery personnel in readiness; operate only searchlights Nos. 5, 7, and 15.
3. Do not fire unless the enemy comes within destructive range (5000 yards) or attempts to run by.
4. Information to Coast Defense Commander as soon as the cruisers are sighted.

D,
Colonel, Commanding

(c) CLASSES OF THE CRUISERS SEEN

Four cruisers sighted; one class 12, three class 11.

(d) TRACK SHEETS

Track sheets herewith. [Not reproduced.]

X,
Battle Commander

II. PERIOD OF ACTIVITY

This is characterized usually, as was the case in the last exercises, as a "War Condition Period"—a period admitting of many conceptions as to the conditions which should obtain in order to simulate war operations.

The proper conception of a war condition period is dependent upon the object of such a period. If the object is *instruction*, a certain line of action will give best results; if the object is a test of tactical knowledge of commanders, the line of action will be different from the foregoing; and yet again, if an *endurance* test is contemplated, a third form of procedure must be followed. Nothing is more fatal than attempting to get results with all the contradictory conditions incident to the foregoing diverse phases operating at the same time.

For success we must have instruction *or* test, nót instruction *and* test—the two do not go hand in hand.

Incidental test of system and matériel in connection with instruction of the personnel is feasible; but if the latter is the object, it must be made the controlling factor, and other theories of war condition periods eliminated.

If instruction be the paramount idea of the exercises, definite phases illustrating the various forms which attacks may assume should be arranged, with intervals for rest and conference, use being made of every facility to the end that the minds of the participants may be fresh and keen for their work. An endurance test in this connection is an anomaly. Furthermore, the above-mentioned phases should take the forms that naval authorities advocate *as proper* in attacking fortifications.

The Admiral of the attacking fleet after the exercises of the last year wrote in part as follows:

> The Navy's endeavor has been to vigorously attack the army fortifictions in every possible manner. In many cases attacks have been made using methods that are greatly at variance with accepted theories of naval attack. In making these attacks in this manner the Navy does not advance the idea that they are good tactics; to the contrary it is well known that, unless under the greatest stress, battleships would not be sent against fortifications in the manner they have been during these exercises. These attacks have been necessary not only for the benefit of the Coast Defenses, but to show the naval officers what would be the result should they attack in such manner.

The line of action indicated in the foregoing was taken up at our request, and was *excellent* in that it involved a *definite* program; but *bad* in that the members of the Defense, under the conditions laid down, had every reason, aside from their own judgment, to believe that the Navy was simulating a real attack. Attacks such as those referred to in the quotation from the Admiral, which, however, as has been stated, were in accord with our request, are good for a certain character of instruction; but everyone should be apprised of their true significance.

It is to be admitted that the imagination was strained at times; for instance, when the destroyers, within 3000 yards, smoked up for a couple of hours or more. The maneuver, however, was to demonstrate a smoke screen. Coincidently with this and similar attacks (explained after the event by the Admiral's letter) we were trying to get data by an elaborate scheme as to the necessary ammunition to withstand a fleet's attack. The instance cited gives a good idea as to the value of the data.

With the kind of attacks indicated; with emphasis on the necessity for ammunition conservation; and with instruction and endurance test, all at once, it is easily to be conceived that tactical commanders had varied conditions to contend with.

There are advocates of establishing war condition periods for endurance tests in the strictest sense of the term, with simulation of investment and imposition of privations incident thereto; this has the saving clause of strenuosity. Results would be in no way commensurate with effort. It could not be done properly, and it is a mistake to embark on any undertaking when it is recognized *ab initio* that it can not be done properly. If there is one thing we are sure of, it is the endurance qualities of the American soldier when there is necessity for endurance; it needs no test; his ability to stand the gaff has been demonstrated too often. Daily strenuosity to the extent of a full day's work in one's profession with periodic combined exercises on a basis suited to the object to be attained, is the real safe and sound policy for enduring results.

The main features pertaining to the Coast Artillery service to receive attention and to be reported upon after the exercises of last year were:

Ammunition service.
Ammunition supply.
Facilities at batteries for personnel.
Fire-control for mortars.
Interference with mines.
Searchlight location and service.
Tactical employment of the defensive elements.

There were numerous other matters of a theoretical or minor nature to receive attention, but they would not be of interest here.

The period of activity was inaugurated by the following special situation given out at 1:00, P.M., August 3rd:

> Black fleet has established temporary bases at ——— Sound and ——— Bay.

Lookouts were established and the command ordered manned at 1:00, P.M., as it was understood there would be no demonstrations prior to 12:00 o'clock midnight.

Destroyers and submarines were picked up soon after midnight, the first shot being fired about 1:00, A.M. It was to be anticipated that destroyers would be used for reconnoitering; so the question was raised at once whether it was good tactics to fire under the circumstances, a parallel being attempted with procedure of land troops in similar cases. I was more or less inclined for a time to the view that it was not; but on mature consideration found that view *academic* to a degree. A reconnoitering destroyer was covered by a searchlight beam immediately in front of a retired rapid fire battery at 800 yards range. No more propitious time for disposing of an important element of the fleet would ever occur again, with no possibility of disclosing any feature of importance. Comparing such a vessel to a land patrol, in order to decide upon the course to pursue, is not sound tactics.

Destroyers were present in the battle area until daylight.

There were no further developments until about 9:00, A.M., when a fleet consisting of eight battleships in column, preceded by two groups of destroyers at several hundred yards, appeared from the Montauk direction, as though for a reconnaissance in force. A division maneuvering in the distance towards Block Island was also observed. The reconnoitering fleet came within 7000 yards of the defenses, proceeding at a speed of about eight knots.

It was presumed that the maneuvers on this day would be of the character of a reconnaissance, and no firing was contemplated unless the enemy unduly exposed himself. This he did, and was opened on energetically by the mortars, several ships being disabled (theoretically). It is believed that this is one of the maneuvers referred to by the Admiral in the extract quoted above.

Immediately after the reconnaissance, the maneuvering division of four battleships of the dreadnought class proceeded with a distant bombardment, which was replied to by the mortar battery. In the evening of the 4th, groups of destroyers and submarines maneuvered in the battle area within 2000 yards of the batteries until about midnight. They appeared to be reconnoitering for mines and were trying to make a smoke screen. Nothing material resulted from either undertaking.

A blockade by division also was established on this day.

In the forenoon of August 5th, very long range bombardment was indulged in; and in the afternoon a division holding subcaliber practice, with the annulling flag displayed, came within 4000 yards of the batteries. The flags could not be distinguished at long range, so some firing took place from the shore batteries.

Submarine periscopes were noted in the battle area, often within 800 yards of the batteries. At this short range the periscope made a very good aiming point.

During the evening, the destroyers and submarines repeated their previous maneuvers immediately under the guns. They were supported by firing from the battleships at long range; but it is impossible that this battleship firing could have had any appreciable effect, for the ships were beyond the searchlight range.

The morning of the 7th was uneventful. During the afternoon the smoke screen effort was repeated while some destroyers were pulling at cables. The screen was unsuccessful and the destroyers were tugging at the cables within 3000 yards of the gun batteries. To appreciate what would have happened to them needs little imagination.

In the evening, destroyers passed inside and fired upon the fortifications from Fishers' Island Sound.

The battleships did not come within 9000 yards.

On the morning of the 8th there was a dense fog, so it was doubted that the fleet would maneuver; but about 9:30 the fleet emerged from the fog at 5000 yards from Fort Wright and proceeded through The Race, the dreadnought division attaining a speed of more than fifteen knots opposite Race Point. The other ships were at a considerable lower speed. On account of the short time involved and the small proportion of shore guns to ships, this maneuver would have been successful for a number of the ships at least; but that it would have been attempted at all presupposes the mine-field cleared.

There was nothing in the afternoon.

In the evening, about 9:30, destroyers were sighted at some 5000 yards, but soon were enveloped in a smoke screen so as not to be seen from Fort Wright. The atmosphere was muggy and a gentle breeze was blowing from the sea—ideal for the smoke screen, which was established so effectively that the battleships could not be fired at from Fort Wright. Moreover, I am of the opinion that it would not have been possible to prevent this screen by firing on the destroyers which were making it.

Though the fleet was perfectly visible to the forts on the other side of The Race and was attacked by them, yet the maneuver demonstrated the possibility of a perfect smoke screen for defenses *on one side of a channel*, if propitious weather conditions prevail.

CONCLUSIONS

My conclusions on the main points enumerated before are as follows:

Ammunition service.—Satisfactory.

Ammunition supply.—Distribution not satisfactory.

Facilities at batteries for personnel.—Absolutely essential to have them in the immediate vicinity of the batteries.

Fire control for mortars.—Pits should admit of separate control. The divisions on one day attempted sinuous courses with a view to determining whether this would interfere with mortar firing; and it did, for the reason that it was insisted that the plotters should perform their duties as though the course was straight, though the general character was observed from the first few points. It may be stated with confidence that plotters can predict satisfactorily from the plotted course and from information communicated by observers. It is to be considered further that ships' fire would be materially affected by sinuous courses, unless it is argued that chance shots from ships at illy defined land targets are to be relied upon, which seems to be the tendency in some quarters.

Searchlight location and service.—Searchlights should be located for day protection and not immediately on the shore line. They should be located so that *two* lights, preferably not immediately alongside each other, should cover each water area. Control of all searching lights should be under the battle commander, and of illuminating lights under a commander in the immediate neighborhood of the batteries for which the light is illuminating a target. All lights should be searching lights, certain ones *automatically* becoming illuminating lights when targets are assigned the respective fire-commanders.

"Mine light" is a misnomer, there being no difference whatever between the principles of operation of a so-called mine light and an illuminating light for a fire command.

Orders to lights should be given using the assigned numbers of the lights; but names are necessary for designating targets. Usually the name of some prominent point in the battle area is available; for example: F_3 target in wilderness, F_5 target in Lobos.*

Interference with mine field by naval vessels.—There were planted a few isolated groups of mines, and a prognostication to the effect that no one could plant a group of mines on such a water area and go out and find it at night (let alone interfere with it) in a reasonable time, was amply verified.

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* See paragraph 557, C.C.A.D.R., No. 5, Jan. 28, 1914, for commands to be used by fire commanders.

We often find writers referring to raids on mine fields and to sweeping methods with an air of assurance; but reference to such methods with any confidence is a certain indication of no experience with them. I repeat here what I have often said before, that there are no sweeping or countermining methods extant which can interfere materially with a mine field, provided there be any protecting guns whatever.

Tactical employment of the defensive elements.—The battle command stations were connected by a telephone line on which the Coast Defense Commander's stations were bridged. As a result of the exercises I think the bridging of the Coast Defense Commander's administrative headquarters on the battle line the proper arrangement, the Coast Defense Commander exercising only supervisory tactical functions and proceeding to such battle station as he sees fit for the purpose, the senior battle commander exercising his functions in his absence.

In conclusion, I will say that the work of the tactical commanders was excellent and showed a high standard in the Coast Artillery service—I say Coast Artillery service and not Coast Defenses of Long Island Sound, because only a small percentage of the commanders belonged to my regular command.

VELOCITIES OF PROJECTILES UNDER WATER

By Lieutenant GARRET L. SCHUYLER, United States Navy

In 1910 a special 8-inch gun was fired under water and the projectile's time of passing several screens determined. Although this determination was not the primary object of the test, it furnishes what is probably the best existing data on the subject of velocities under water.

We start by picking a power of the velocity proportional to the resistance. In foreign experiments bullets were fired through water contained between the parchment heads of a cylinder. The travel in water was in one series of firings the same in all cases, while the velocity of impact was varied. The velocity after passing through 13 cms. was measured, and the results taken to show that the resistance, R, is equal to KV^2, where K is a constant depending on the projectile and V is the velocity.

Having this, the method has been (see p. 91 of *Engineering* for July 20, 1906) to deduce an expression for S, the distance traveled from a point where the velocity was V_1 to a point where it has diminished to V.

$$R = KV^2 \qquad (1)$$

$$\tfrac{1}{2} MV^2 = E \qquad (2)$$

M is the projectile's mass and E is its kinetic energy. Differentiating, we have,

$$\tfrac{1}{2} M.\ 2VdV = dE \qquad (3)$$

therefore,

$$MVdV = dE = RdS = KV^2dS \qquad (4)$$

and dividing,

$$dS = \frac{MVdV}{KV^2} = \frac{MdV}{KV} \qquad (5)$$

therefore,

$$S = \frac{M}{K} \log_e V + C \qquad (6)$$

Making $V = V_1$ and $S = 0$, we have,

$$C = -\frac{M}{K} \log_e V_1$$

$$-S=\frac{M}{K}(\log_e V_1-\log_e V) \tag{6'}$$

The 8-inch gun was fired with a charge that gave 784 f.s. in air and presumably the same under water.

The shot passed through a screen 13.5 feet distant, .0181 seconds after it cut a wire across the muzzle, and, after a total travel of .0412 seconds, pierced a screen which had been placed 28.5 feet away. In such case, we calculate the mean velocity to the first screen as 747 f.s.; between the two screens, 650 f.s.; and for the total travel from the muzzle to the second screen, 688 f.s.

It is difficult, however, to tell just what points these velocities correspond to. If we slow down to a stop in one mile, we are not necessarily at half speed at the half mile point. Since the greater decrease in velocity takes place at the higher speed, the mean velocity corresponds to a point somewhere in the first half of the interval.

There had been worked out a curve of velocity and travel for a 6-inch shell, but the value of K was merely approximated. The approximation involved an estimated velocity, and this later was found to have made K about twice its proper value. While this curve was, therefore, not to be relied on for values, it was thought, from examining it, that mean velocities corresponded to those obtained at about the four tenths point in the measured interval; and so, giving values in feet and in foot seconds, we have Table 1.

TABLE 1

V	S
784	0.0
747	5.4
688	11.4
650	19.5

Letting W be the weight of the shell, and g the acceleration due to gravity,

$$K=\frac{W}{g}\,\frac{(\log_e V_1-\log_e V)}{S} \tag{7}$$

Now with W 260 lbs., g 32.2, the values of K for this 8-inch shell are .0722, .0778, and .0926, the average value being .0808.

$$C = -\frac{M}{K}\log_e V_1 = -\frac{260}{32.2\times .0808}\times 6.66 = -666.4$$

$$-S = \frac{M}{K}\log_e V - C = \frac{260\times 2.30}{.0808\times 32.2}\log_{10} V - 666.4 \qquad (8)$$

$$-S = 230\log_{10} V - 666.4 \qquad (9)$$

TABLE 2

V	log V	230 log V	$+S$
750	2.875	661.9	4.5
700	2.845	655.1	11.3
650	2.813	647.7	18.7
600	2.778	639.7	26.7
550	2.740	630.9	35.5

The results computed in Table 2 are given in Table 3, for each two feet of travel:

TABLE 3

S	V
0	784
2	769
4	754
6	738
8	723
10	710
12	695
14	682
16	669
18	655
20	642
22	629
24	616
26	604
28	592
30	578

of K we can revert to the case of
s was fired at 446 meters per second
ater, the remaining velocities being
values are given in British units.

TABLE 4

S	V	K
.000	1464.0	
.131	1405.6	.0001200
.263	1372.8	.0000910
.427	1308.4	.0000994
.754	1209.0	.0000952

The average value of K, obtained as from Table 1, is .0001014.

Assuming a similarity of form, the resistance coefficient being proportional to the square of the diameter, it will be proportional to the $\frac{2}{3}$ power of the projectile's weight.

The projectile weighs .012125 pounds.

log 260............2.41497
log .012125.........8.08368

$4.33129 \times \frac{2}{3} = 2.88753$
log K for bullet $= 6.00604$

Calculated value of K for 8″ = .0783, log 8.89357

The observed value of K for 8-inch is .0808, so that the disagreement is 3.2%. In the case of the 8-inch shell the value of K averages .001952 times the $\frac{2}{3}$ power of W. In sea water of density 1.026, this value should be increased in the same ratio, making it almost exactly 2/1000 times the $\frac{2}{3}$ power of W, for all sizes of projectiles.

As a final check, the velocity was used to get the time-travel curve. Time of travel =

$$\int \frac{dS}{V} \tag{10}$$

The curve of the reciprocal of V was drawn, and this integrated in Table 5.

The agreement of these values with the times of travel to the screens is remarkable. Another shot fired at the 28.5 foot screen alone was found to have reached it in .0472 seconds, instead of in .0412 seconds as required on the other firing. The curve splits the small disagreement. The time of getting to the middle screen comes out as closely on the curve as can be plotted.

TABLE 5

S	$\frac{1}{V} \times dS$	T (the time of travel)	S
½	.00128		
2	.00260	.00128	1
4	.00265	.00388	3
6	.00270	.00653	5
8	.00276	.00923	7
10	.00282	.01199	9
12	.00288	.01481	11
14	.00294	.01769	13
16	.00300	.02063	15
18	.00306	.02363	17
20	.00312	.02669	19
22	.00320	.02981	21
24	.00325	.33010	23
		.03626	25
26	.00332	.03958	27
28	.00340	.04298	29
30	.00348	.04646	31

CONCLUSION

The quadratic law of resistance gives highly satisfactory results. With $R = KV^2$, K, the resistance coefficient, can be taken as $2/1000\ W - 2/3$, for any weight of projectile. This value has been found to check within 4% for projectiles as dissimilar as a 5.5 gram bullet and an 8-inch shell of 260 pounds, and without additional experiments it can not well be improved on. The above formulas give results as accurate as the variation from round to round and the accuracy of measurement permit them to be checked. No formula can do more than that.

Tables 6 (a)* and (b)* show what Navy shell should do if they penetrate the water before striking a ship. A ricocheting shell, of course, meets greater resistance as its point swings upward, but these values are probably approximate up to 50 or 60 feet for shells that do not ricochet.

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* See page 190.

TABLES 6 (a) and (b)

(UNITS ARE FEET AND FOOT-SECONDS)

(a) (*S* as a function of *V*) *Distances*

Velocities *V*	Caliber						
	6-in.	7-in.	8-in.	10-in.	12-in.	13-in.	14-in.
2000	0	0	0	0	0	0	0
1800	9	11	12	15	18	20	21
1600	18	21	25	30	36	40	42
1400	27	32	37	45	54	59	63
1200	40	45	53	64	79	85	91
1000	53	60	72	88	106	116	125
800	68	78	90	111	135	148	160
600	90	105	120	150	182	200	211
400	113	131	152	190	209	250	267

(b) (*V* as a function of *S*) *Velocities*

Distances *S*	Caliber						
	6-in.	7-in.	8-in.	10-in.	12-in.	13-in.	14-in.
0	2000	2000	2000	2000	2000	2000	2000
20	1550	1630	1680	1745	1790	1800	1810
40	1175	1260	1350	1470	1560	1600	1625
60	900	1000	1110	1230	1320	1370	1440
80	690	800	920	1060	1190	1240	1270
100	500	630	730	900	1050	1100	1150
120	—	490	600	760	910	970	1040
140	—	—	500	650	780	850	910
160	—	—	—	560	700	750	800
180	—	—	—	—	610	675	720

COAST DEFENSE IN THE CIVIL WAR*

OPERATIONS ON THE MISSISSIPPI RIVER†

By 1st Lieut. WALTER J. BUTTGENBACH, Coast Artillery Corps

General Situation ‡

After the capture of Island Number Ten, April 8, 1862, the Federal forces under General Pope, embarked on transports, and, under the protection of Flag-Officer Foote's squadron, proceeded down the Mississippi River, arriving near Fort Pillow on the 14th of the month. Plans were made for a joint military and naval attack to take place on the 17th; but that day General Pope received orders from General Halleck to proceed at once to Pittsburg landing, taking along his entire force; so he started that same afternoon. The withdrawal of the military forces at this point made, of course, the projected attack impossible; so it was abandoned. In the meantime, the indecisive battle of Shiloh had been fought. The Confederate forces had been concentrating at Corinth; but, on Halleck's advancing towards that point, the Confederates fell back along the Mobile and Ohio Railroad, evacuating Corinth May 30th.

Federal troops were now in possession of the Memphis and Charleston Railroad at Corinth, and the Confederate position at and above Memphis, having been turned, was untenable. Fort Pillow was therefore abandoned on the night of June 4th, and Fort Randolph the next day, the greater part of the garrison falling back on Vicksburg.

At Memphis, however, the Confederates had a strong fleet, and before giving up that city determined to try conclusions

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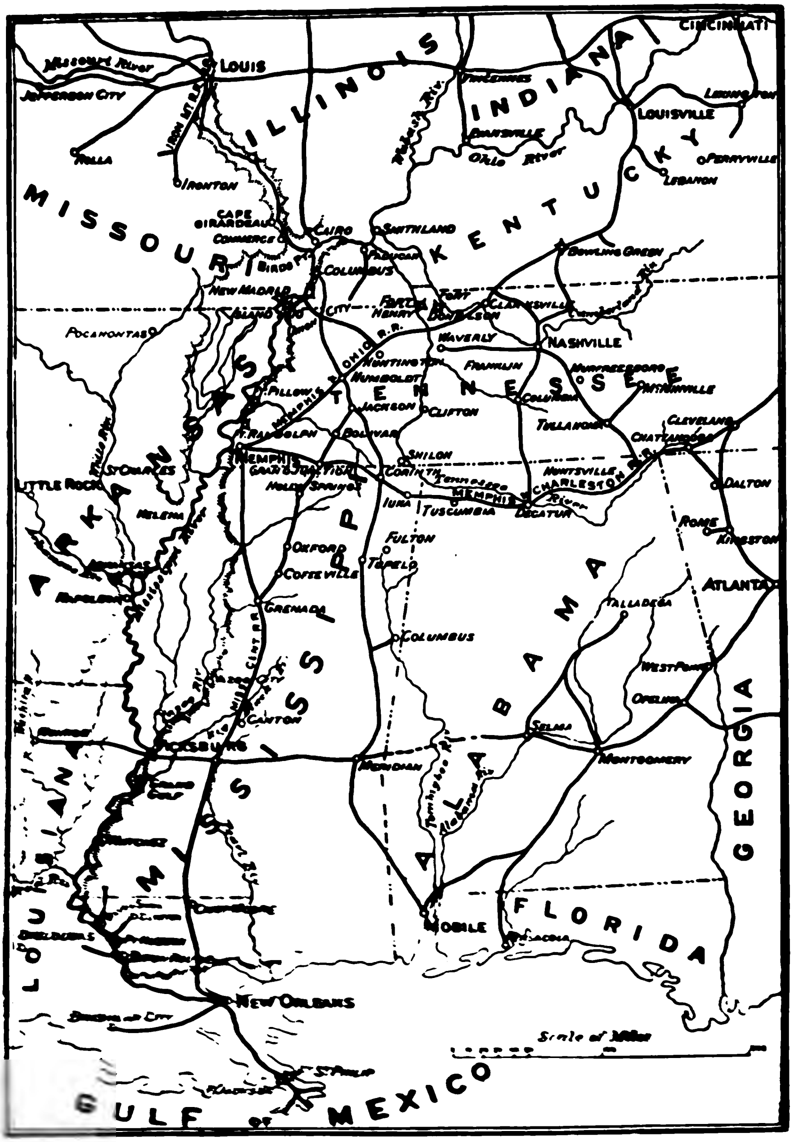
* See note to "Coast Defense in the Civil War, Fort Sumter, S. C. (First Attack)," in Journal U. S. Artillery, for March-April, 1912.

† Though not strictly an account of an operation in coast defense, this account of the operations on the Mississippi River is introduced at this point in the series of articles on "Coast Defense in the Civil War," in order to present in chronological order accounts of operations of guns afloat against guns ashore that took place during that war.

‡ In order to connect the narrative of events of this article with that of the preceding, the general situation has been expanded into a narrative of intervening events.



From "Campaigns of the Civil War. The Mississippi," by Francis Vinton Greene; copyright, 1882, by Charles Scribner's Sons. 163

THE THEATRE OF WAR IN THE WEST, 1862-1863 with Foote's fleet, which during all this time had remained in the vicinity of Fort Pillow. The Confederates hoped either to destroy this fleet or to cripple it. On the 9th of May Foote was relieved of command, on account of a wound received at Fort Donelson, and was succeeded by Commodore Davis.

On May 10th at 7 a.m., the Confederate fleet of eight vessels, coming out from under the guns of Fort Pillow, attacked the Federal fleet, then consisting of seven gunboats. A naval battle ensued: two of the Federal vessels were rammed and sunk, while the Confederate vessels were promptly disabled by the superior ordnance of the Federal fleet, four being rendered helpless. At the end of an hour the Confederates withdrew to the fort, towing their disabled vessels with them, and subsequently went down the river. Fort Pillow was abandoned June 4th. Commodore Davis proceeded down the river and at dark the next day was within two miles of Memphis. At daylight, June 6th, the Confederate fleet was lying off Memphis, the fleet consisting of the same vessels that had been encountered off Fort Pillow, and another attack took place.

The Federal fleet now consisted of five vessels, having in all 68 guns, and 4 rams. The Confederates had eight vessels, but only 28 guns. At 4:20 a.m. the Federal fleet moved down the river and engaged the Confederate vessels in a running fight, which, when ended after an hour or so, had resulted in the destruction of three of the Confederate vessels and the capture of four, one only having escaped. The city of Memphis was surrendered and taken possession of by the Federal fleet.

Commodore Davis remained at Memphis till June 29th. During this time an expedition was sent up the White River destroying the Confederate works at St. Charles. On the 29th Commodore Davis left Memphis with four of his vessels, six mortar boats, and some transports; and on July 1st arrived at Young Point, a few miles above Vicksburg, where he joined forces with Farragut's fleet, which by this time had come up the river.

Before proceeding further in our account, let us look for a few minutes at Farragut's fleet. After the passage of the forts below New Orleans, the fleet arrived at New Orleans April 24-25, and then after a few days proceeded up the river. Baton Rouge was taken May 8th and Natchez May 12th. No serious fortifications were encountered below Vicksburg, which was reached by Farragut's advanced division on May 18th. The surrender of Vicksburg was demanded, but the demand was refused. A day or so later Farragut himself arrived with additional vessels and two transports carrying some 1500 men, part of General Butler's command brought up from New Orleans. A reconnaissance was made and a council of war held, decision being made against the proposition to run by the batteries, on account of the inadequate force available.

Nothing further was done at this time, Farragut returning to New Orleans June 1st, and the troops being sent back to Baton Rouge. On his arrival at New Orleans, Farragut found most urgent letters from the Navy Department impressing upon him the importance of clearing the Mississippi, only one point of which (Vicksburg) was at that time in the possession of the Confederates.

After Farragut's withdrawal a desultory bombardment was carried on by the naval vessels that remained near Vicksburg, while the Confederates were busily engaged building additional batteries and bringing in additional men. Farragut did not believe he could take Vicksburg without the aid of a large military force, yet he prepared as quickly as possible to make the attempt.

The mortar flotilla consisting of sixteen vessels under Porter was sent on ahead and reached Vicksburg June 20th. On the same day Farragut left Baton Rouge with the large vessels of his fleet accompained by transports carrying some 3000 men, consisting of four regiments of infantry and batteries.

This force reached Vicksburg June 25th, having stopped on the way near Natchez and Grand Gulf, to attack batteries that had been erected since the first expedition up the river. These works, however, were now abandoned on the approach of the fleet.

The entire fleet assembled at Vicksburg June 25 consisted of 3 ships, 7 gun boats, carrying in all 106 guns, and 16 mortar boats, each having one 13-inch mortar.

The Confederate armament consisted of some 40 guns, the batteries being on bluffs about 200 feet high, giving them a plunging fire upon the vessels.

Two ships and five gunboats of Farragut's fleet passed the batteries of Vicksburg early on the morning of June 28th, after an artillery duel lasting some two hours. As a result of the action, Farragut anchored with a portion of his fleet above the peninsula on which were the batteries of Vicksburg; while another portion was below. Farragut's loss was 15 killed and 42 wounded, and the damage to his fleet was not very serious.

The shore batteries suffered no losses and it was evident that the ships could do no real damage to them; but it is of interest to note that after the action Farragut stated that the forts could be passed again as often as might be required.

The fleets of Farragut and Davis now remained in the vicinity of Vicksburg, some above and some below the batteries; while the Confederates continued their work on the batteries, increasing the number at Vicksburg and also building some at Grand Gulf, fifteen miles below.

On July 15, some light gunboats that had been sent up the Yazoo River on a reconnaissance to locate the whereabouts of the Confederate ram *Arkansas*, reported as under construction somewhere on the river, were seen coming back chased by the *Arkansas*, which deliberately kept on and passed through the Federal fleet, taking cover under the batteries of Vicksburg. Because Farragut had not imagined that the *Arkansas* would venture near a formidable fleet of war vessels such as he then had, his vessels on this morning were without steam and unable to move, so he had to content himself with firing into the *Arkansas* as she went by. Chagrined, Farragut at once determined to run past the batteries again that night and destroy the ram. Accordingly, the run-by was made with a loss of 5 killed and 16 wounded; but owing to darkness and confusion no damage was done to the *Arkansas*.

The river was now beginning to fall and Farragut was becoming anxious about his large vessels, which drew considerable water. He feared that they would be unable to return to deep water. On July 20th, however, he received orders to return, and on July 22nd started down the river with his fleet and the troops he had brought up.

On the same day Davis with his fleet went up the river; so Vicksburg was left free.

On July 29th Farragut reached New Orleans again.

In all the engagements thus far, the Confederates had lost only twenty-two men killed and wounded.

On the 30th of July, they made an attack on Baton Rouge but were unsuccessful. Two days later, however, they gained possession of a point below the mouth of the Red River, Port Hudson, some thirty miles above Baton Rouge, where they immediately began to build heavy batteries. The works then established remained in possession of the Confederates till after the fall of Vicksburg nearly a year later.

The Federal troops had abandoned Baton Rouge and returned to New Orleans.

Thus the Federal forces let slip the chance to take and hold the river, because no troops appeared available, Halleck on June 28th informing Farragut that it would be impossible to detach troops to cooperate at Vicksburg. No further effort being made, the Confederates assembled additional troops, again assumed the offensive, and regained control of the Mississippi River from Baton Rouge to Helena, Arkansas, some 300 miles in a straight line and nearly 600 miles along the river. Throughout this length they built batteries or strenthened them wherever the river touched the eastern bluffs—at Port Hudson, at Natchez, at Grand Gulf, at Vicksburg; and they built a battery (Fort Hindman) a short distance up the Arkansas River, under cover of which their gunboats were able to operate. In consequence, the Confederacy held on to the Mississippi for nearly another year.*

SPECIAL SITUATION

The state of affairs on the Mississippi River having been recounted in general terms, it is obvious that the problem before the Federal Government was the reduction of Vicksburg, which it was thought could be accomplished best by way of the river, which afforded an easy line of communication under convoy of the Navy not so liable to serious interruption as a land line would be.

The Confederate line, of which Vicksburg was the center, had its right at Haynes' Bluff, a fortified position twelve miles from Vicksburg and near to and commanding the Yazoo, while its left was at Grand Gulf, some sixty miles below Vicksburg by river, though not over thirty miles by land.

There were for the Federals to consider, therefore, works at Haynes' Bluff, Grand Gulf, Port Hudson, and Vicksburg, primarily, and, secondarily, Fort Hindman on the Arkansas.

OPPOSING FORCES

CONFEDERATE

The two most important points in the chain by means of which the Confederates held their section of the Mississippi, were Vicksburg and Port Hudson.

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* The foregoing abstract has been taken largely from F. V. Greene's *The Mississippi* of Scribners' *Campaigns of the Civil War* series.

Vicksburg is 400 miles above New Orleans, and some 400 miles below Memphis. The river, after pursuing its irregular course through the low bottom lands, turns to the northeast five miles from the city, and on reaching the cliffs on which the city stands sweeps abruptly around and continues its course southwest, parallel to its original course, thus enclosing a narrow tongue of low land from three fourths to one mile wide. The bluffs at their greatest elevation, just below the point where the river first touches them, are 260 feet high. The bluffs do not rise perpendicularly from the river. From the point of greatest elevation for a distance of some two miles, in the vicinity of Vicksburg, the crest of the bluffs lies fairly near the river, but below the city it gradually recedes, at the same time that its elevation diminishes to about 150 feet.

This position was the strongest on the river, the height of the banks, combined with the narrowness and peculiar winding of the river, placing the batteries on the hillsides above the reach of guns aboard ships.

At the time of Farragut's first attack, there were twenty-six guns in position, as follows:

2 10-inch guns
1 9-inch gun
4 8-inch guns
5 42-pdrs., S.B.
2 24-pdrs., S.B.
7 32-pdrs., rifled
2 24-pdrs., rifled
1 18-pdr., rifled
2 12-pdrs., rifled

Of these, one 9-inch gun, three 8-inch guns, and one 18-pdr. were located on the highest point of the bluffs above the town and in the bend of the river, where they could bring a raking fire upon the ships both before and after they had passed the batteries. Just above these were located four 24-pdrs. Half a mile below the town was a water battery about 50 feet above the river, mounting two 32-pdr. rifled guns and four 42-pdr. guns. This battery was afterwards extended from Fort Hill on the north through the town and along the Warrenton ridge till it met the land batteries on the south. The eleven other guns were placed along the crest of the hills below the town, distributed over a mile or more, and it was difficult for the attacking ships to locate them exactly.

Since the entire distance to be run was about three miles, the river current three knots an hour, and the speed of the vessels that could be brought against the batteries was not over eight knots, it required at least three quarters of an hour for each vessel to pass the front of the batteries.

Besides the guns already mentioned, there were field batteries in the city.*

The batteries were not all built at one time; on May 12, 1862, three batteries out of ten were finished; on May 18th, six were complete; and finally, at the time of their ultimate surrender, July, 1863, the river batteries comprised:

8 10-inch columbiads
1 9-inch Dahlgren
1 8-inch columbiad
1 7.4-inch Blakely gun
1 7-inch Brooks rifle
1 6.4-inch Brooks rifle
3 42-pdrs., S.B.
2 32-pdrs., S.B.
8 32-pdrs., rifled
1 18-pdr., rifled
1 20-pdr., Parrott
1 10-inch mortar
1 8-inch siege howitzer

There were also thirteen pieces of light artillery surrendered.

This, of course, does not include the works around Vicksburg on the land side, which were some eight miles long, and held by the main body of Confederate troops.

Of Confederate troops in the vicinity of Vicksburg there were on November 30th, 1862, some 6000; on December 24th of the same year, 12,000; at the end of January of the next year, 25,000, with 15,000 more near enough to be available, if needed, making a total of 40,000 available. These numbers, of course, incident to the campaign, varied considerably. In the final surrender 31,600 Confederate troops were included.

Port Hudson consisted of a series of batteries mounting in all some twenty siege guns, located along a bluff at an elevation of about eighty feet above the water. The parapets were of an average thickness of twenty feet, and were surrounded by a ditch of which the bottom was not less than fifteen feet below the top of the parapet.

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* See pages 91-97, Mahan, *The Gulf and Inland Waters*, Scribner series.

There were also land defenses, the line of works being from three to four miles in length.

On February 22, 1863, the garrison was 16,000; in March, over 20,000; but in April, only about 7000, the others having been sent away—in the main, to Vicksburg.

Grand Gulf on April 29th, 1863, contained some thirteen guns, eight of which were 32-pdrs. or smaller.

Fort Hindman, also known as Arkansas Post, was a permanent bastioned work of square trace, 300 feet on the side, standing on ground of such elevation as to be above the reach of floods, on the left bank of the Arkansas River at the head of Horse Shoe Bend. It had three casemates—one in the curtain facing the approach up the bend, and one each in the face of the northeast and southeast bastions, commanding the same approach. In each bastion casemate was a 9-inch gun and in the curtain casemate an 8-inch gun. There were four smooth bore light pieces on the parade of the fort and six similar pieces in a line of rifle pits exterior to and above it. There was also a line of trenches a mile and a half below the fort; but these were untenable as soon as the fort came under fire. The garrison at the time the work was attacked was reported by the Confederates to contain 3000 effective men, although a greater number were actually surrendered.

In addition to the works specifically mentioned, there were also works at Haynes' Bluff above Vicksburg, and minor works on some of the rivers emptying into the Mississippi.

FEDERAL

Mississippi operations were carried on by several groups of vessels—the Mississippi Flotilla under Porter; the West Gulf Squadron under Farragut; and, in the early operations, Foote's fleet, later commanded by Davis. There were also a large class of auxiliary vessels, such as rams and river gunboats, the lighter of which were called tin-clads.

On October 1, 1862, the flotilla of river gunboats and other armed vessels which up to that time had been operated by the Army, were turned over to the Navy, and all vessels thereafter operating on the Mississippi River were called the Mississippi Squadron. In January, 1863, this squadron numbered:

11 Iron-clads
38 armored gunboats
6 rams
15 tugs and dispatch boats

In all, some 70 vessels, whose aggregate tonnage was 16,905; personnel, 5500; and armament, 304 guns.

The composition of this fleet varied from time to time. For a detailed table of its composition during the Vicksburg operations, see the Century *Battles and Leaders of the Civil War*, Vol. III, page 581.

Of land forces taking part in the Mississippi River campaigns there was the army under General Grant, whose main objective was Vicksburg and whose military operations overshadow the work of the fleet, and the forces under General Banks, who conducted the siege of Port Hudson.

It is, of course, not the intention to take up in detail the operations of the armies operating against the land side of the various works but to limit ourselves chiefly to the river side.

Narrative of Events

The Navy, beginning early in December, 1862, made effort to clear the Yazoo, as it was intended that General McClernand should land along that river and make the first attempt upon Vicksburg from that direction. This expedition is of no particular interest, except that it is one of the few cases of the successful use of mines, or torpedoes, as they were then called. The *Cairo*, a Federal vessel ran among Confederate mines with the result that there were two explosions under her bow and one under her stern, the former being so severe as to lift guns from the deck. The vessel was at once pushed into the bank and attempts were made to keep her afloat, without success, however, for she sank in twelve minutes, going down in six fathoms and becoming a total loss. The mines were merely demijohns filled with powder and ignited by means of a common friction primer rigidly secured inside. Wires led from the primer of one mine to that of another. The mines were arranged in pairs and anchored some twenty feet apart.

On December 8th Sherman was directed to move down with troops from Memphis in order to cooperate with Porter in the reduction of Vicksburg. The expedition started December 20th, arriving on the 26th on the Yazoo, on the low banks of which it landed. The force consisted of fifty regiments and ten batteries, in all some 32,000 men and 60 guns.

The gunboats accompanying the expedition occupied the river for some eight miles.

An assault was made against the works in front of Vicksburg on the 29th, but failed. The expedition was then given up and on January 2nd the troops were reembarked, the transports moving out into the Mississippi and anchoring five miles above Vicksburg.

McClernand, joining the expedition at Milliken's Bend on January 3rd, assumed command; and, "having nothing better to do," decided to make an attack on Fort Hindman, on the Arkansas River some 50 miles from its mouth, a fort which is better known, perhaps, under the name of Arkansas Post. This fort commanded the approach to Little Rock, Arkansas, and was particularly obnoxious to the Federals at this time, by reason of being the base from which small Confederate expeditions were sent against their communications on the Mississippi, which, in a straight line, was only fifteen miles away.

There were three iron-clads, *De Kalb*, *Louisville*, and *Cincinnatti*, as well as the light-draught gunboats, sent to accompany the expedition. The troops were moved by transports, which also towed the gunboats. The total strength of the expeditionary force was some 32,000 infantry, 1000 cavalry, and 40 pieces of artillery.*

On January 9th, 1863, the troops were landed about four miles below the fort and moved around to its rear, while one of the light vessels moved up and cleared out the trenches. At about 5:30 p.m., the troops having been reported ready, the three iron-clads advanced to within 400 yards of the work and opened fire. The vessels took up a position with the *Louisville* in the center, the *De Kalb*, on the right, and the *Cincinnatti* on the left, each having one of the fort's casemate guns assigned to it as target. The vessels attacked bow on with three guns each, and the naval fire against the work was so superior that the Confederates were entirely unable to reply to it. During the action the lighter vessels also came up and fired shell and shrapnel. One of them, the *Rattler*, was ordered to run by the fort and enfilade it, which was successfully done, the vessel later rejoining the fleet. No assault, however, was made by the Army.

On the next day, at 1:30 p.m., the land forces being again reported ready, the fleet renewed its attack, moving to within a few hundred yards of the fort and opening fire with some sixty-six pieces. The guns opposed to the fleet were silenced by 4 p.m., and several naval vessels ran by, going further up the river, so as to destroy a ferry and cut off the fort.

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* See *Battles and Leaders of the Civil War*, Vol. III, page 160, for a detailed table of the forces.

The artillery with the Federal land forces also engaged the fort, and, at 4:30 p.m., the troops having worked their way close up to the entrenchments, orders were issued for a general assault; but before it could be made the fort was surrendered, with some 5000 troops.

In the action, every gun opposing the fleet was either destroyed or dismounted and the casemates were knocked to pieces.

The *De Kalb* had 1 32-pdr. dismounted and 1 10-inch gun destroyed, and was severely damaged in the hull. The other vessels were repeatedly struck but not rendered unfit for service, due, perhaps, to their armor protection. All damages sustained were caused by shots entering the ports. The Navy's casualties were 6 killed and 25 wounded.

On the 16th, when McClernand's forces were still further up the river continuing the destruction of minor Confederate works, General Grant directed their return to the lines before Vicksburg. On January 24th the Federal vessels lay off the mouth of the Yazoo River and extended from there to the neck of land opposite Vicksburg, where General Grant's forces were disembarking.

The Confederates, at this time, had full control of the river between Vicksburg and Port Hudson, as well as the communications along the Red River.

Porter now determined to send some of his vessels down the river, notwithstanding the fact that the batteries of Vicksburg had been much strengthened since Farragut passed them the preceding year, for the importance of the work justified the risk. Accordingly, he designated a ram, the *Queen of the West*, to run the batteries, which on February 2nd she did, though in running by she was struck some twelve times by shot and had one of her guns dismounted. No men, however, were hurt.

On the 12th Porter sent down the river the *Indianola*, which, when fired upon by the batteries, went on at full speed, and, though remaining under fire for twenty minutes longer, was not struck.

A third vessel, a small Confederate transport, having been tured, the three vessels moved up and down the river waters, including those of the Red River, harassing the Confederates for some three weeks, but were subsequently destroyed in action with the Confederates, or otherwise.

When the news of these happenings reached Farragut, he determined on coming up the river again.

On March 12th he was at Baton Rouge where his fleet was assembled. On the morning of the 14th he anchored with his fleet off Profit's Island, seven miles below the bend on which Port Hudson is situated. Here he conferred with Commander Caldwell of the *Essex*, who had for some time occupied the point with half a dozen mortar schooners.

From this point up the river, the course lies nearly due north; then it takes a sharp turn to the west-southwest for a distance of one or two miles. Port Hudson is situated on the east bank just below that bend. The bluffs, from 80 to 100 feet high, on which the batteries were placed, begin at the bend and extend for a mile and a half down the river.

At this time there were mounted at Port Hudson nineteen heavy guns, as follows:

2 10-inch columbiads
2 8-inch columbiads
2 42-pdrs.
2 32-pdrs.
3 24-pdrs., S.B.
8 80-50-pdrs., rifled

Admiral Farragut contemplated passing these batteries. He had with him:

Hartford	24 guns
Monongahela	10 "
Mississippi	17 "
Richmond	24 "
Genesee	8 "
Albatross	6 "
Kineo	6 "

For making the run-by, the larger ships, except the *Mississippi*, were directed to take a gunboat on the port side secured well aft, so to keep the port battery clear; and each vessel was to keep a little to the starboard of the one next ahead, so as to be able to use the bow guns. Shortly before 10 p.m. the vessels weighed anchor and advanced in the following order: *Hartford*, *Richmond*, *Monongahela*, and *Mississippi*.

About eleven o'clock, as they drew near the batteries, the *Hartford*, in fact, having already passed the first battery, the Confederates fired rockets and opened with their guns. Along the river bank locomotive headlights had been placed and large fires built to light up the river in order that the vessels might be seen; but the firing of the fleet and of the guns on shore soon created such smoke that these preparations were rendered useless. The smoke, settling down upon the water in a still atmosphere, soon hid everything; so that not only could the vessels not be seen from land, but also the pilots of the vessels could not see.

The *Hartford*, in the lead, pushed on and got clear of the batteries, losing 1 killed and 2 wounded, but sustaining no serious damage to the vessel.

The *Richmond*, with a gunboat alongside, coming next, had its safety valve struck by a shot, which released the steam, and deprived the vessel of its motive power. Unable longer to breast the current, the *Richmond* drifted down the river and, after some narrow escapes from the fire of the fleet, was carried out of range by its gunboat.

The *Monongahela*, with a gunboat, came next; but after a series of mishaps neither vessel got by the batteries, as both had their engines disabled and their rudders carried away. The *Monongahela* had 6 killed and 21 wounded. The gunboat had no casualties.

The *Mississippi*, in the meantime, had passed the *Monongahela*, but ran aground and could not be gotten off. So, under fire from three of the shore batteries, she was abandoned in flames, and subsequently drifted down the river and blew up. Some 64 of her crew were missing, of whom probably 25 had been killed.

That the run-by ended rather disastrously, is due, perhaps, not so much to the Confederate fire as to circumstances: it was dark, the channel was intricate, the current was rapid (about five knots), and the speed of the ships was low.

The *Hartford* and the gunboat with her were now in rather a dangerous position; though it may be said the object of the expedition had been attained, for the Red River was blockaded and was not again open to the Confederates, notwithstanding they still held Port Hudson.

The two vessels went up the river, and on the 20th arrived below Vicksburg and got in touch with Porter, after having on the way engaged a battery of four pieces at Grand Gulf, where they lost 2 men and 6 wounded.

Porter, meanwhile, had been engaged in various small expeditions, cooperating with the Army in its movements around Vicksburg, for which purpose he had navigated various streams emptying into the Mississippi. These operations are generally known as the Bayou Expeditions. They entailed much work and finally failed.

On the evening of March 31st Farragut with the *Hartford*, a gunboat, and one of the rams, went down the river. The batteries at Grand Gulf were passed again with small loss, and on April 1st Farragut reached the Red River. On the 6th he was near Port Hudson and very anxious as to the news of the rest of the fleet; so his secretary, Mr. Gabandau, volunteered to pass Port Hudson in a skiff at night and did it successfully, reaching the vessels below at ten o'clock that night.

General Grant, in the meantime, was busy with the problem of Vicksburg and was moving his troops along the west bank of the river, with a view to reaching New Carthage by means of a detour of thiry-five miles, although the straight line distance is but twenty miles. As soon as this movement was decided upon, Porter made arrangements for running the batteries of Vicksburg with the greater part of his fleet. Coal barges were to be towed on the starboard side of each vessel, so as to have an available fuel supply; and, as there was no intention of engaging the Confederates, every precaution was to be taken to avoid being heard or seen.

At a quarter past nine on the night of April 16th the fleet got under way. It consisted of the *Benton*, *Lafayette*, *Louisville*, *Mound City*, *Pittsburg*, *Carondelet*, and *Tuscumbia*, and had an armament consisting altogether of 79 guns. Some army transports, carrying stores only, accompained the fleet.

The river batteries at this time contained 31 pieces of heavy artillery and 13 of light.

The fleet moved down at a speed scarcely exceeding the drift of the current. At 11:16 p.m. the guns of the batteries opened up and the engagement soon became general. It was another running fight, for the vessels kept on moving.

The armed vessels received no injury unfitting them for service, and by 3:00 a.m. were all anchored twelve miles above New Carthage, again ready to cooperate with the Army. Ten or twelve men had been slightly wounded, a few coal barges had been sunk, and one transport had been abandoned by her crew. And, while other transports had been more or less severely damaged, yet the movement was considered such a comparative success that Grant directed six more transports to run the batteries. It was done on the night of the 22nd, but in the movement one was sunk.

As the number of the transports was limited, it was decided to move the troops by land to Hard Times Landing, twenty-five miles below New Carthage. The fleet, with the transports, followed down the river.

Five miles below Hard Times on the opposite shore is Grand Gulf, where was located a battery that had engaged the Federal vessels repeatedly in the course of Farragut's movements up and down the river. But, the Confederates having strengthened this battery after the fight at Port Hudson, Farragut did not care to engage it unaided and remained off the Red River on the Mississippi, keeping it blockaded, while arrangements were made for a joint attack by land and naval forces.

Above Grand Gulf is the mouth of the Big Black River, by which supplies from the Red River country were transported to the interior of the Confederate lines, the river being navigable for some sixty miles. Eight hundred yards below the mouth of the Big Black River is the Point of Rocks, rising about seventy-five feet above the river. Here was the upper battery, consisting of two 8-inch rifles, one 8-inch smooth bore, and a 30-pdr. rifle on a wheel mount. A line of rifle pits and a covered way led from this point to the lower fort, three quarters of a mile farther down, in which were mounted: One 100-pdr. rifle, one 8-inch smooth bore, and two 32-pdrs. There were also five light rifled guns and ten 20-pdrs. in various parts of the works. The Point of Rocks battery was close to the river. All the works were ordinary earth works.

The plan was for the fleet to silence the works, and then for the troops to cross on transports under cover of the gunboats and take the place by assault.

On the 29th at 7:00 a.m. the fleet got under way, the *Pittsburg* leading, and the *Louisville*, *Carondelet*, and *Mound City* following, all firing upon the upper battery as long as their guns bore, and then passing on to the attack of the lower work, which was the real task assigned them; while the remaining vessels, the *Lafayette*, *Tuscumbia*, and *Benton*, following the first four, took up the engagement with the upper work.

The *Benton* was struck about 11 a.m. and rendered unmanageable. Her place was taken by the *Pittsburg* of the first division, which had just moved up, the lower fort having been silenced. The entire squadron now concentrated their fire upon the upper work, the Point of Rocks battery, all keeping under way and firing at varying ranges. About noon the *Tuscumbia's* engine became disabled and she was compelled to drop down below Grand Gulf. The action was kept up with vigor till 1 p.m., when the fire from the upper fort also slackened considerably.

But notwithstanding the slackened fire, General Grant as well as Admiral Porter now realized that the works were too high and too strong to be taken from the water side; so it was decided to land troops from the transports, and to march down to the point immediately below Grand Gulf. Accordingly, the vessels were directed to withdraw to Hard Times.

The guns of the shore batteries had been so well protected by their elevation above the river that none had been seriously damaged during an engagement of some five hours. Nor had the fleet, through roughly handled in some instances, been very materially damaged. The *Benton* had 7 killed and 19 wounded; the *Tuscumbia* 5 killed and 24 wounded; the *Pittsburg* 6 killed and 13 wounded; the *Lafayette* none killed and only one wounded; while the others had no casualties.

That evening the fleet with the transports, got under way at 8 p.m., and, with the loss of only one man, ran by the batteries and anchored at a point four miles below Grand Gulf.

On April 30th, for the purpose of preventing the Confederates at Vicksburg from sending down reinforcements to Grand Gulf to oppose the landing of the Federals there, a feigned attack in conjunction with the 15th Army Corps was made at Haynes' Bluff by the vessels of Porter's fleet that had remained above Vicksburg. The fleet was in action from 11 a.m. to 2 p.m. on the 30th, and the feint was continued the following day, at eight in the evening of which the troops participating were withdrawn and prepared to join the main body of the Army, the vessels engaged returning to their anchorage off the mouth of the Yazoo. In the attack the vessels suffered severely, one, the *Choctaw* being struck as many as 46 times; but, in spite of that, casualties among the personnel were not numerous.

The work at Haynes' Bluff was subsequently abandoned on the 17th of May due to the advance of Grant's troops, and at that time had in it fourteen heavy guns, including 8-inch and 10-inch smooth bore guns and 7-½-inch rifles.

On the 3rd of May Porter came up the river, intending again to attack the works of Grand Gulf, but found they had been evacuated, the march of the Federal forces inland having rendered them untenable. Investigation showed that, while the earth works had been torn to pieces by the fire of the fleet, yet with the exception of two 32-pdrs. in the lower battery which had been dismounted and broken, the guns were still in position. A large quantity of ammunition also was found.

The same day General Grant arrived and Grand Gulf was now made his base of supply instead of Bruinsburg.

Farragut, during this time, was still blockading the Red River, operating between it and Port Hudson, capturing small Confederate vessels and destroying stores that fell into his hands. Also an expedition had been sent up the Red River, the Black River, and various small streams; and on the 4th of May an engagement was fought on the first mentioned river between three of the smaller vessels and a work called Fort De Russey. The action lasted forty minutes, when the vessels withdrew, the force being too small for a successful attack. When, however, on the 5th Fort De Russey was attacked by four vessels of Porter's fleet which had arrived the evening before, and two gunboats, the fort was found abandoned and all guns removed, except one 64-pdr. So the vessels contented themselves with destroying the works, and then continued up the river.

On the 8th Porter returned, although some of the smaller vessels were left on patrol duty along the various streams.

Farragut now felt he could leave Porter in entire charge, so himself returned to New Orleans by one of the bayous, leaving four of his vessels on blockade duty above Port Hudson.

On the 23rd of May Port Hudson was duly invested, General Banks' forces that had been operating in Louisiana reaching the Mississippi some five or six miles above Port Hudson, and General Augur, with another body of Federal troops, coming up from Baton Rouge and joining them there. An unsuccessful assault being made on the 27th, the troops settled down to a regular siege.

The vessels of the fleet, including some mortar schooners, now engaged the river batteries of Port Hudson, which at the time consisted of four 8-inch and 10-inch columbiads and two heavy rifles. The exchange of fire was long continued, and it is estimated that the Confederates between May 23rd and June 26th fired at the fleet from these guns some 1000 shell.

On the 18th of May, Porter received word from Grant concerning the operations in front of Vicksburg, so he moved up the gunboats below Vicksburg to fire on the hill batteries. On the 19th, six mortar boats were also moved up with orders to fire day and night as rapidly as possible.

On the 21st Porter's vessels engaged the Vicksburg batteries for some two hours in anticipation of an assault by the Army. But, as the assault was not successful, regular siege operations were begun, and Vicksburg, as well as Port Hudson, was formally invested May 27th.

In addition to keeping up a bombardment from the vessels, the fleet during the siege of Vicksburg landed some thirteen heavy guns and organized them into siege batteries manned by sailors and naval officers. But the Navy's principal task was to keep open river communication, and Porter sent various naval expeditions up the different streams, none of which, however, need be mentioned here.

On July 4, 1863, Vicksburg surrendered, and on July 9th, Port Hudson, thus opening the Mississippi River from Cairo to the Gulf and ending the work of the Western Armies as well as the Mississippi squadron.*

Ammunition and Casualties

It is interesting to note that in the attack on Grand Gulf, which lasted from 8:00 a.m. to 1:00 p.m., April 29, 1863, while the Federal fleet fired some 2500 projectiles, the Confederate loss was 3 killed and 15 wounded. The works, however, were pretty well ploughed up. The Federal loss on this occasion was 19 killed and 56 wounded, the vessels receiving several hundred hits. The fleet had in action 81 guns against 13 on shore.

In one of the early actions against Vicksburg, on July 28, 1862, in which thirty-five vessels were engaged for an hour and a half, not a single Confederate gun was either disabled or silenced. And it was estimated that up to that time the fleet had fired between 20,000 and 25,000 projectiles, with resulting casualties in the batteries of 7 killed and 15 wounded and 2 guns temporarily disabled. The necessity for an attack from the land side was believed to be conclusively proved.

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* This summary is taken from *The Gulf and Inland Waters,* Mahan (Scribners' *The Navy in the Cival War* series), pages 90-174.

COMMENTS

1. In all these actions on the Mississippi, Haynes' Bluff, Vicksburg, Grand Gulf, and Port Hudson, is illustrated the value of height of site. At Vicksburg the batteries were generally over 200 feet high, and to that fact they probably owed their great immunity from serious damage by the fleet.
2. The practicability of a run-by in the absence of obstructions, is again demonstrated.
3. We have also in these operations examples of the successful use of mines.
4. A purely naval attack with experienced troops on shore gives but little chance of destroying guns ashore: in almost every case a combined military and naval action is required, either deliberately carried out or, at least, threatened.
5. The vulnerability of fortifications for defense against naval attack, when attacked in rear, is once more shown.
6. The operations on the Mississippi River early showed the disadvantages of the Army's having a flotilla of its own, and good policy demanded that it be combined with the Navy, thus securing the unity of command so essential in all military operations.
7. There is to be noted also the futility of leaving each arm, the Army and Navy, operating alone; for Vicksburg could have been taken in the early part of 1862, had troops been ready and on hand to cooperate with the Navy. As it was, the Navy had to give up its control of the river and do its work all over again.
8. Many of the fleet actions can be considered nothing more than artillery duels: and, like many artillery duels in land warfare, they were absolutely indecisive. It requires, generally, more than artillery fire to dislodge a force from its position: for decisive results an assault in some form is needed.

AUTHORITIES

VICKSBURG

Official Records of the Union and Confederate Armies, Series I, Vol. 15, pages 6-35; Vol. 17, pages 599-697; Vol. 24, pt. 1, pages 473-481, 517-518; Vol. 24, pt. 2, pages 336-341; Vol. 52, pts. 1 and 2, and Atlas.

Official Records of the Union and Confederate Navies, Series I, Vol. 18, pages 575-652; Vol. 19, pages 3-75; Vol. 24, pages 217-224, 550-566; Vol. 25, pages 15-124.

GRAND GULF

Official Records of the Union and Confederate Armies, Series I, Vol. 15, pages 6-35; Vol. 24, pt. 1, pages 573-576; and Atlas.

Official Records of the Union and Confederate Navies, Series I, Vol. 24, pages 600-630.

FORT HINDMAN (ARKANSAS POST)

Official Records of the Union and Confederate Armies, Series I, Vol. 17, pages 698-796, and Atlas.

Official Records of the Union and Confederate Navies, Series I, Vol. 24, pages 98-127.

PORT HUDSON

Official Records of the Union and Confederate Armies, Series I, Vol. 15, pages 251-280; Vol. 26, pages 41-183; Vol. 52, pt. 2, Atlas.

Official Records of the Union and Confederate Navies, Series I, Vol. 19, pages 665-705; Vol. 20, pages 43-93; Vol. 20, pages 206-272.

GENERAL

The Mississippi, Green (Scribners' *Campaigns of the Civil War*), pages 1-28, 54-233.

The Gulf and Inland Waters, Mahan (Scribners' *The Navy in the Civil War*), pages 90-174.

Battles and Leaders of the Civil War, Vol. III, pages 441-600.

History of the Navy, Maclay, Vol. II, pages 350-381.

PROFESSIONAL NOTES

BLEIAZID: LEAD HYDRONITRIDE[*]

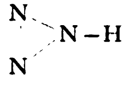
A NEW DETONATING COMPOUND IN PLACE OF MERCURIC FULMINATE FOR MILITARY AND TECHNICAL PURPOSES

Translated from the German for the JOURNAL OF THE U. S. ARTILLERY by
1st Lieut. A. J. Stuart, C. A. C.

The discovery of hydronitric acid and its salts occurred in the year 1890. The discoverer, Curtius, called attention to the highly explosive properties of the free acid and its metallic salts. The explosive industry at that time practically disregarded this important discovery. Neither the published researches of Will and Lenze in the year 1893, through which the applicability of silver hydronitride, lead hydronitride, and mercury hydronitride for detonators was made known, nor the publication of Berthelot and Vieille in the year 1895, in which the close relationship of the properties of mercuric fulminate and mercuric hydronitride were pointed out, sufficed to overcome the timidity of the industry toward the commercial development of such explosive substances.

In the year 1907 Wohler and Matter published their researches on the subject of detonating substances for explosives, in which the high efficiency of silver hydronitride for detonating explosives such as picric acid, trinitrotoluol, trinitrobenzene, etc., was set forth. In that paper, the experimental comparison of the silver salt with mercuric fulminate and those other explosives having the power to initiate detonations, again suggested the commercial employment of the heavy metal salts of hydronitric acid in detonators.

Hydronitric acid, N_3H,



a light, volatile, very explosive liquid, has a decidedly acid character and forms salts with all metals, its heavy metal salts, principally, possessing the property of exploding with great brisance[†] upon the application of blows, friction, flame, etc. Among the heavy metal salts of particular merit, the lead salt possesses favorable physical characteristics (very slight solubility in water, high specific gravity). This compound has acquired an unexpected importance since the Rhinish-Westphalia Explosives Co. took up the development of a process of manufacture, in place of the earlier very dangerous method of preparation by re-crystallization from a hot solution, by which the manufacture and handling of lead hydronitride has been made not more dangerous than that of mercuric fulminate.

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[*] A translation of a pamphlet, *Bleiazid*, issued by the Rheinisch-Westfalische Sprengstoff-Actien-Gesellschaft, Koln, Germany.

[†] Those explosives which, when brought to explosion, develop their maximum pressure in an exceedingly short time, are said to possess *brisance*.

Brisant explosives affect only objects in the immediate neighborhood of the explosion, and are usually able to produce their full effects when unconfined or confined only by weak covering.—Tr.

In the following discussion, the principal characteristics of lead hydronitride will be compared with those of mercuric fulminate, the substance hitherto exclusively employed to initiate detonations.

SENSITIVENESS TO BLOWS AND SHOCKS

The sensitiveness of each of the three explosives, pure mercuric fulminate, a mixture of 80% mercuric fulminate and 20% potassium chlorate, and lead hydronitride, was tested with a 700 gram drop-hammer, the maximum height of drop being 30 cm. The minimum height at which explosion was obtained with a small compressed sample was:

Pure mercuric fulminate	10-12 cm.
Fulminate-chlorate mixture	22-26 cm.
Lead hydronitride (Bleiazid)	23-26 cm.

It is seen that the sensitiveness of lead hydronitride to blows is about the same as that of the mercuric fulminate-chlorate mixture and is considerably less than that of pure mercuric fulminate.

STABILITY UNDER HEAT

a. *"Puffing-off" Temperature*

The behavior of mercuric fulminate and of lead hydronitride when quickly heated, was compared by immersing, for about one half minute, a copper capsule containing a small sample of the explosive in a molten metal bath of a light fusible alloy in which a thermometer was placed. If no explosion occurred during the half minute, the temperature of the bath was raised 5° and the operation repeated until the puffing-off of the sample occurred. By this method the following "puffing-off" temperatures were obtained:

Mercuric fulminate	170°-190° C.
Lead hydronitride	310°-320° C.*

This temperature for lead hydronitride is considerably higher than for mercuric fulminate, showing that the former has the greater stability under rapid heating.

b. *Stability at 50°C.*

For comparison of stability at this temperature separate samples of mercuric fulminate and lead hydronitride were placed between watch glasses and kept in a thermostat at 50°C. for 114 days. Under similar conditions, the several samples of both mercuric fulminate and lead hydronitride lost in weight an average of .012% weekly.

After 114 days of storage at 50°C., neither substance exhibited any outward change, neither gave an acid reaction with litmus paper, and the explosive efficiency of neither was at all impaired, indicating that the stability at 50°C. of lead hydronitride compares favorably with that of mercuric fulminate.

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* Kibler has determined the puffing-off temperature for mercuric fulminate as 210° C. In this case, however, the sample was immersed for only five seconds which may account for the slightly higher temperature obtained.—Tr.

As an additional experiment, lead hydronitride was stored for about three and a half years at a constant temperature of 50°+C. At the end of that period it had not lost its brisance even under these extremely severe conditions.

INFLUENCE OF SUNLIGHT

Several heavy metal salts of hydronitric acid, namely, lead hydronitride, silver hydronitride, and mercury hydronitride, were exposed in glass containers for one month to sunlight, and examined daily. It was observed that the surfaces only of all three substances changed color, and ultimately after the month's exposure attained a dark brown to black coloration, Subsequent analysis of the compounds showed that the chemical properties of all were not in the least affected by the exposure to light.

CHEMICAL EFFECT OF CONTACT WITH DIFFERENT METALS IN THE PRESENCE OF MOISTURE

For these experiments the following metals were selected: copper, brass, steel, aluminum, and tin. About 5 grams of mercuric fulminate and an equal amount of lead hydronitride were spread out on brightly polished plates of the above mentioned metals, moistened with about 3 cc. of water and stored over water. All samples were repeatedly examined each day and remoistened when necessary. These experiments showed that important changes were brought about in mercuric fulminate, in the presence of moisture, by contact with each metal—in some cases in as little as fifteen minutes. In the case of copper and brass, a distinct gray coloration was apparent on the edge of the mass of fulminate; with aluminum, in the same time, a tarnishing with grayish saline concretions was noted; while, after one day with the other metals, distinct spots and changes in color could be observed. After fourteen days the action of aluminum was very marked, that of brass, copper, tin, and steel being somewhat less marked.

Lead hydronitride, on the other hand, in the presence of moisture, exhibits very little tendency to react with metals. After one day with copper a slight green coloration on the edge of the mass of the sample was seen. With brass a change in color was observed after two days. After fourteen days contact with copper, brass, and aluminum, the moist hydronitride was somewhat changed, while with steel and tin it was unaffected.

From the foregoing it is evident that mercuric fulminate under the conditions stated exhibits a greater tendency to react with the five metals than lead hydronitride.

LEAD PLATE TEST

Samples of pure mercuric fulminate, a mixture of 80% mercuric fulminate and 20% potassium chlorate, and lead hydronitride, were prepared and tested in the following manner. About 2 grams of each substance was pressed into a cylindrical copper capsule, 6.85 mm. outside diameter and 45 mm. long, with a pressure of 200 kg. per sq. cm. Each capsule was then placed in the center of a square lead plate, 5 mm. thick and supported only at the edges, and detonated.

In Fig. 1, which exhibits four lead plates for each compound, it is seen that all three compounds completely perforated the 5 mm. plates, and that,

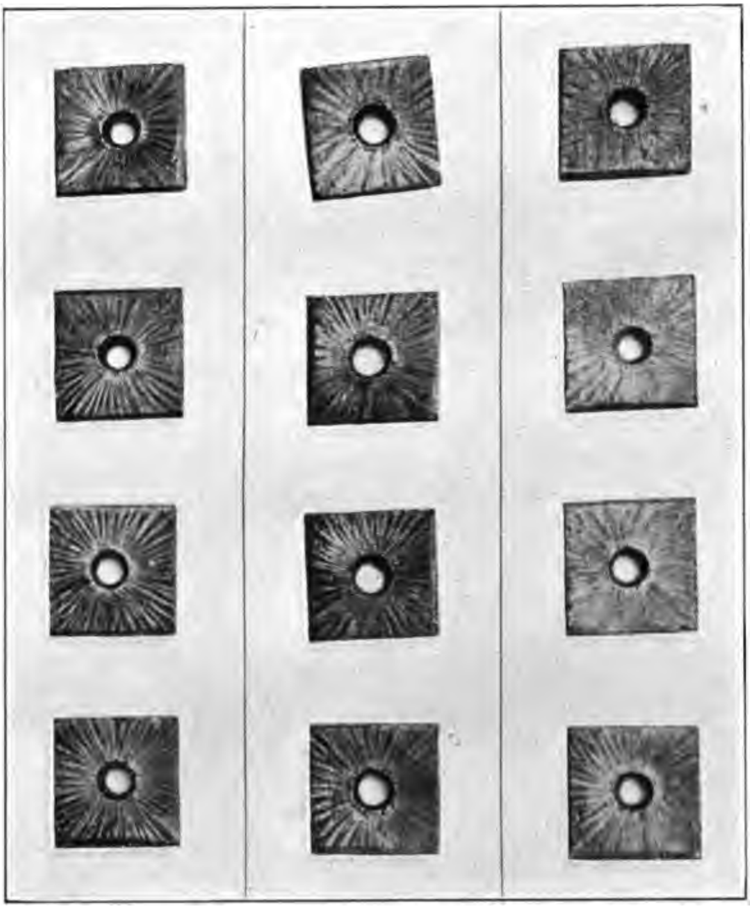


Fig. 1.

Pure mercuric fulminate

Mixture of 80% mercuric fulminate and 20% potassium chlorate

Bleiazid: lead hydronitride

under the experimental conditions of low compression, the hole in the case of the mixture of fulminate and chlorate is a little larger than that in the case of pure mercuric fulminate and lead hydronitride. On all plates fine radial lines, or streaks, covering the surfaces of the plates, can be observed, made by small particles of copper, the capsule being blown to dust by the explosion. These copper particles were projected symmetrically in all directions by the explosion and left the radial marks on the surface of each plate. The radiating streaks afford a good guide in determining the brisance of the explosion of the substance under these conditions: the finer the streaks, the greater the brisance of the explosive. In the case of slow acting explosives, the inclosing capsule is insufficiently split up, in which case the fine streaks are entirely absent, there being instead coarse splotches or rough scratches. The lead plate test is therefore adapted for determining the brisance of detonators and military fuses.

From Fig. 1 it is seen that lead hydronitride, under a pressure of about 200 kg. per sq. cm. and inclosed in a copper capsule, detonates with about the same brisance as pure mercuric fulminate and the mixture of 80% fulminate and 20% chlorate under similar conditions.

TRAUZL LEAD BLOCK TEST

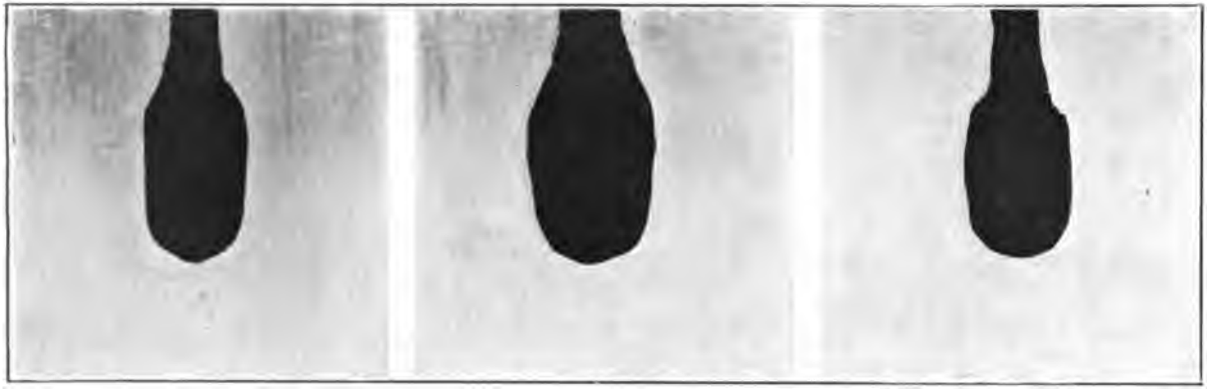
To test the relative strengths of the three substances, mercuric fulminate, a mixture of 80% mercuric fulminate and 20% potassium chlorate, and lead hydronitride, 2 grams of each was again placed in copper capsules 6.85 mm. in diameter and 45 mm. long. Each capsule was placed in the axial bore hole, 7 mm. in diameter and 55 mm. in depth, of a cylindrical block of cast lead, 1C0 mm. in diameter and 100 mm. high, and detonated in the center of the block. The volume of the cavity produced by the explosion was measured by filling it with water from a graduated burette.

Fig. 2 shows a longitudinal section of three blocks which were cut open. The cavity caused by the fulminate-chlorate mixture was the largest and measured about 33.6 cc.; while that caused by mercuric fulminate under the same conditions was only 25.3 cc., and that of lead hydronitride only 21.5 cc.

The large cavity of the fulminate-chlorate mixture, as compared with that of pure mercuric fulminate, is due to the oxidation to CO_2, by the oxygen carrier $KClo_3$, of the free carbon produced in the explosion, a greater amount of heat being liberated thereby. On the other hand, a mixture of lead hydronitride and an oxygen carrier does not produce a greater cavity than pure lead hydronitride, for the reason that the molecule of the hydronitride splits up into metallic lead and nitrogen, neither of which is oxidized. The great effect in the lead block test is due to the liberation of heat and has no direct connection with the brisance. This statement agrees with the well known fact that explosives consisting of a mixture of powdered metallic aluminum with an oxygen carrier, which components liberate a great amount of heat in uniting, produce extraordinarily large cavities in the lead block test.

INFLUENCE OF PRESSURE

That property of mercuric fulminate and its mixture with potassium chlorate by virtue of which, when greatly compressed, it loses its high brisance and is unable to detonate other explosives, is well known to the explosives industry. This undesirable quality, known as "dead-pressed," is particularly unfavorable to the production of the certain, compact, and powerful initiator of detonations which the explosives industry demands.



2 grams mercuric fulminate
25.3 cu. cm.

2 grams mixture of 80% mercuric fulminate and 20% potassium chlorate
33.6 cu. cm.

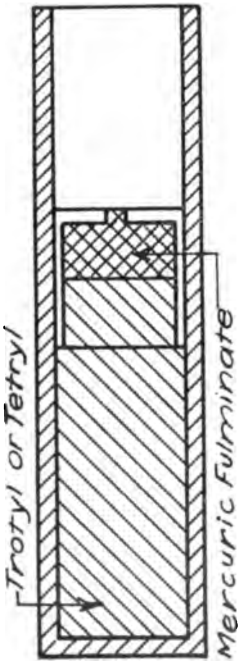
2 grams Bleiazid (lead hydronitride)
21.5 cu. cm.

FIG. 2.

Fig. 3 shows the effect on lead plates of the detonation of about 2 grams of pure mercuric fulminate, mixture of 80% fulminate and 20% chlorate, and lead hydronitride, when the compounds were pressed into the copper capsules with pressures of 200, 2000, 5000, and 10,000 kg. per sq. cm. The process of becoming "dead-pressed," in the cases of the pure mercuric fulminate and the chlorate mixture, can be plainly followed. Only where the loading pressure was 200 kg. per sq. cm. is the brisance of the latter unaffected, while with a loading pressure of 2000 kg. per sq. cm. the "over-compressed" condition is already evident from the disappearance of the fine streaks and the appearance of coarse streaks and scratches. This effect is much greater in the case of the capsules compressed to 5000 and 10,000 kg. per sq. cm., where, without exception, the capsules merely burned. Occasionally one would flash up with a hissing noise when ignited; but no detonations could be obtained, and on the lead plates were left only very small holes or, sometimes, scarcely a hollow.

The behavior of pure mercuric fulminate is similar to that of the chlorate mixture under loading pressures of over 2000 kg. per sq. cm. The pressure of 2000 kg. per sq. cm. is not, however, sufficient to produce the "dead-pressed" condition, in contradistinction to the behavior of the chlorate mixture.

Lead hydronitride, on the contrary, exhibits, under conditions of very great compression, the surprising phenomenon of not only not becoming "dead-pressed," but even of having its brisance greatly increased by the heavier pressure: it produced the largest hole under the heaviest compression. Fig. 3 shows clearly that with increasing pressure the size of the hole in the lead plate and the fineness of the streaks increased, and that the series of plates with the 10,000 kg. per sq. cm. pressure were perforated, while with mercuric fulminate capsules, under the same conditions, no perforations were obtained. This property of lead hydronitride is a very valuable one and gives this substance great importance in the manufacture of military detonators.



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INITIATING CAPACITY

Up to about a year ago, detonators had been exclusively made by pressing mercuric fulminate or a mixture of mercuric fulminate and potassium chlorate into copper capsules, no cover being placed inside each capsule over the charge. During the last year, with a view to improvement, the practice was tried of replacing the essential part of the former charge with a less dangerous and more effective explosive, such as trinitrotoluol[*] or tetranitromethylaniline.[†] Mercuric fulminate or its chlorate mixture was employed only as an initiating charge under a perforated inner

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[*] Trotol or trotyl

[†] Tetryl.

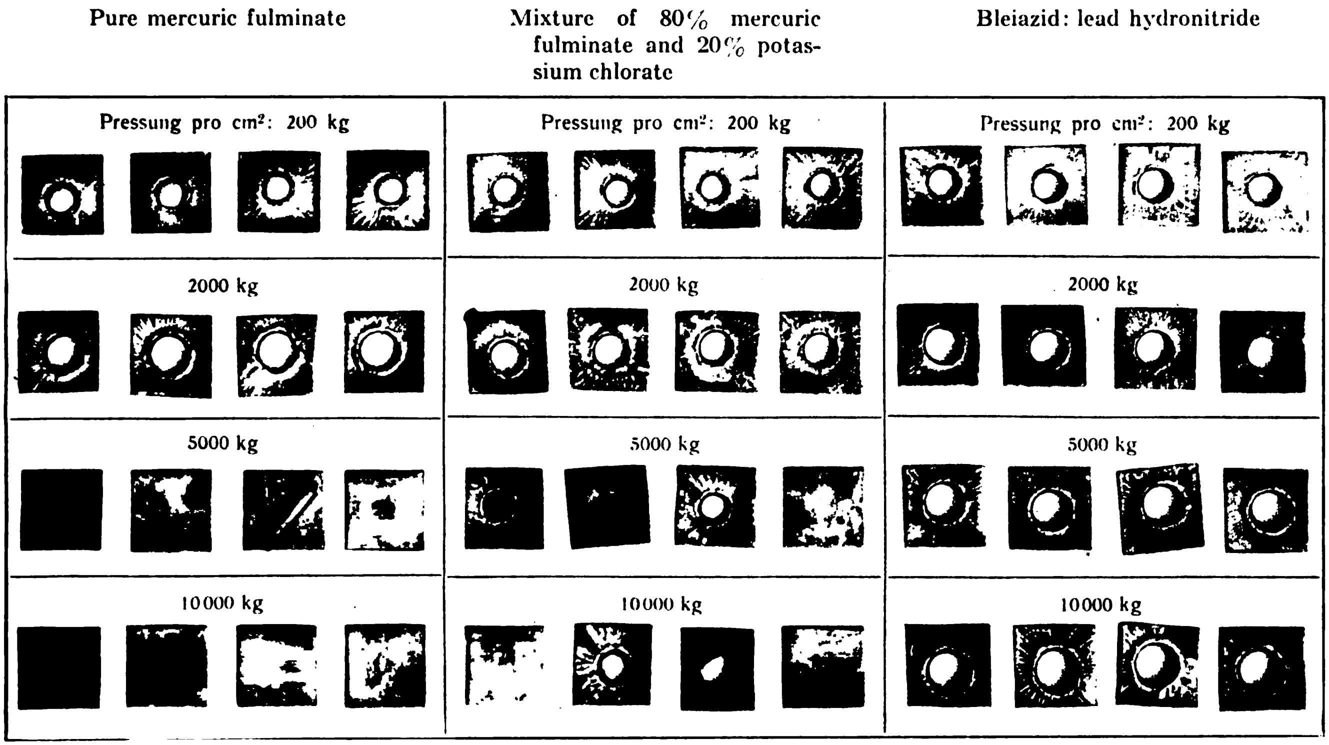
Pure mercuric fulminate
Mixture of 80% mercuric fulminate and 20% potassium chlorate
Bleiazid: lead hydronitride
Pressung pro cm²: 200 kg
Pressung pro cm²: 200 kg
Pressung pro cm²: 200 kg
2000 kg
2000 kg
2000 kg
5000 kg
5000 kg
5000 kg
10000 kg
10000 kg
10000 kg
1427

FIG. 3.

cap placed as shown in the illustration on page 218. It was found that by this arrangement a very considerable amount of initiating charge was necessary to detonate the nitro compound below. It was observed that, with a capsule made in this way, the initiating charge of mercuric fulminate was somewhat too small, only the fulminate detonating and the nitro-compound remaining unchanged.

The experience gained, however, led to the development of a simple method for determining the relative efficiency of pure mercuric fulminate, the 80% mixture with $KClo_3$, and lead hydronitride, for bringing about the detonation of other explosives, such as trinitrotoluol, tetranitromethylaniline, etc. For example: about 1 gram of a nitro-compound was pressed into a cylindrical copper capsule, 45 mm. × 6.85 mm.; then an accurately weighed quantity of the initiating substance was placed in the capsule above the nitro-compound; and lastly a suitable perforated inner cover was inserted. The amount of the initiating substance was decreased until failure of the detonation of the nitro-compound commenced. By this method the following weight of the explosives named were required to bring about the detonation of 1 gram of trinitrotoluol.

Pure mercuric fulminate	.35 gram
80% mercuric fulminate and 20% chlorate	.30 gram
Lead hydronitride	.08 gram

For the detonation of 1 gram of tetranitromethylaniline were required:

Pure fulminate	.40 gram
Mixture of fulminate and chlorate	.20 gram
Lead hydronitride	.01 gram

From the foregoing figures it is evident that lead hydronitride has a much greater efficiency for detonating other explosives than pure mercuric fulminate or the chlorate mixture. Greater certainty of action is secured for detonators in the employment of this substance for the initiating charge, if the minimum charge (.08 gram for trinitrotoluol and .01 gram for tetranitromethylaniline) is considerably exceeded, as, indeed, is always the case in practice, for loading-machines that could accurately measure out such exceedingly small amounts of explosive can scarcely be manufactured.

INFLUENCE OF MOISTURE

The unwelcome property of mercuric fulminate and its chlorate mixture of losing their brisance and, thereby, their ability to detonate other explosives, has also long been known. The explosive industry has striven most zealously to remove this disadvantage, inherent in all detonators and military fuses which contain mercuric fulminate.

a. *Hygroscopicity*

The hygroscopic qualities of mercuric fulminate, of the mixture of 80% fulminate and 20% chlorate, and of lead hydronitride, were compared by the following method: The three substances in quantities of about 5 grams were placed in watch glasses over water in a hermetically sealed receptacle which was stored in a cellar for sixteen days. All three substances after this length of time showed an equally small absorption of moisture, averaging 1.4%, indicating that all are slightly hygroscopic.

b. *Effect of the Admixture of Various Amounts of Water on the Detonating Capacity*

This was determined as follows: the three sbstances, mercuric fulminate, mixture of fulminate and chlorate, and lead hydronitride, were moistened with different quantities of water, accurately measured, and the mixture pressed into detonator shells and tested with the lead plates.

It was found that mercuric fulminate and the chlorate mixture, even with only 1% of water, gave an entirely insufficient perforation of the lead plate, with coincident formation of coarse spray or splotches, wholly analogous to the results produced through excessive compression.

Lead hydronitride, on the other hand, yielded, with 5% of moisture, faultless perforations, with the characteristic fine streaks as conclusive evidence that the brisance of this substance was not in the least impaired.

c. *Storage Under Moist Conditions*

As a final experiment the following four kinds of capsules were packed in an open tin box and stored for 900 days over water in a hermetically sealed, watertight receptacle:

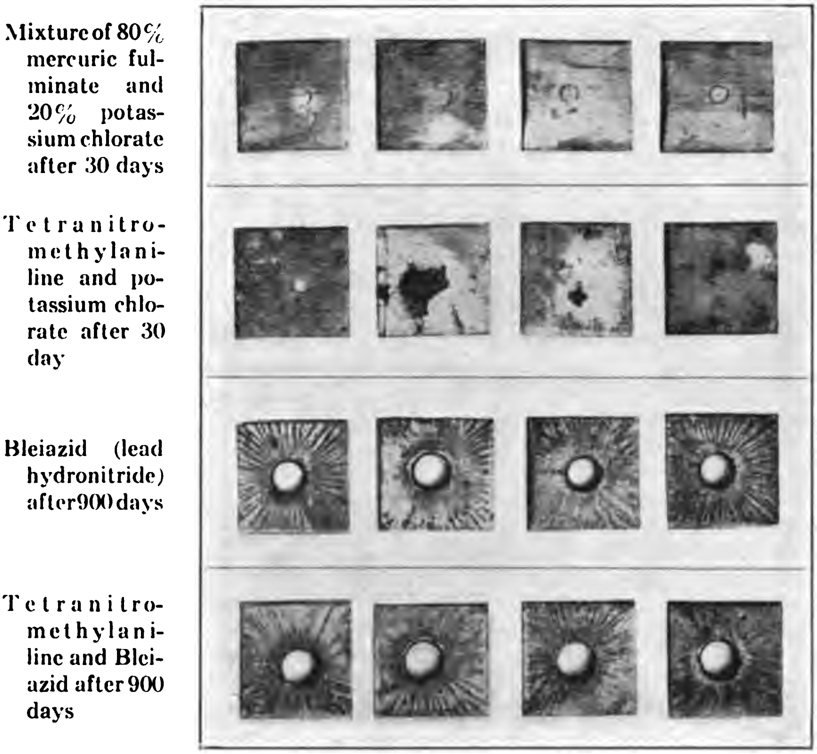
Mixture of 80% mercuric fulminate and 20% potassium chlorate after 30 days
Tetranitromethylaniline and potassium chlorate after 30 day
Bleiazid (lead hydronitride) after 900 days
Tetranitromethylaniline and Bleiazid after 900 days
1128

Fig. 4.

1. Two grams of a mixture of 80% mercuric fulminate and 20% potassium chlorate.
2. Tetranitromethylaniline with an initiating charge of .40 gram of the chlorate mixture.
3. 2 grams of lead hydronitride.
4. Tetranitromethylaniline with an initiating charge of .15 gram of lead hydronitride.

After different intervals of time had elapsed, samples were taken from the different kinds of capsules to determine which kinds were rendered unserviceable through the action of the moisture.

From Fig. 4 it is seen that those capsules containing the chlorate mixture, as well as those charged with tetranitromethylaniline with an initiating charge of the chlorate mixture, were rendered wholly inefficient after the relative short time of 30 days, and were unable to perforate the lead plates. After the ignition of the capsules containing tetranitromethylaniline with an initiating charge of fulminate-chlorate mixture, large pieces of explosive were found, composed partly of still unchanged nitro-compound, a certain proof that the initiating charge of fulminate mixture was rendered inefficient after 30 days storage in the presence of moisture and no longer possessed the power to detonate the nitro-compound.

On the other hand, it is seen that those capsules loaded exclusively with lead hydronitride as well as those containing tetranitromethylaniline with an initiating charge of lead hydronitride, exhibit the surprising result that the continual, unbroken action of moisture for 900 days was unable to affect the brisance of lead hydronitride in the slightest; the capsules containing this substance which were exposed to moisture for this long period of time yielded, as the last two series of lead plates in Fig. 4 show, the same evidence of vigorous explosion.

An important proof that lead hydronitride is unable to react with water is exhibited in the valuable observation of the discoverer of hydronitric acid and its compounds, that this salt after being kept more than 20 years under water did not in the least lose its explosive property.

In view of the foregoing, it cannot be denied that lead hydronitride detonators are completely insensitive to the action of water under the most unfavorable circumstances. This property signifies an extraordinary advance for the industry, and will contribute substantially to secure for lead hydronitride a lasting place in the field of explosives.

The lack of a detonator unaffected by moisture has been keenly felt in coal mines and more particularly in damp mines, where it is practically impossible to keep mercuric fulminate detonators in a serviceable condition. Through the selection of lead hydronitride instead of mercuric fulminate, accidents owing to hang-fires, failure of shots, ignition of fire-damp or coal dust, which frequently have their origin in detonators too weak for the charge, while not wholly avoidable, can be rendered of less frequent occurrence.

RECAPITULATION

In view of the foregoing, the following claims are made·

1. The sensitiveness of lead hydronitride to blows or shock is very much less than that of pure mercuric fulminate and is approximately that of a mixture of 80% mercuric fulminate and 20% potassium chlorate.

2. Lead hydronitride possesses a very considerably higher ignition temperature than mercuric fulminate, and is completely and permanently stable when exposed to temperatures of about 50°C. The chemical composition and brisance of lead hydronitride does not vary in the least through the influence of light.

3. In a moist condition, lead hydronitride exhibits a much greater indifference to the ordinary metals than mercuric fulminate, which changes under continued contact with steel and tin, while lead hydronitride is unaf-

fected by these metals. Copper, brass, and aluminum have considerably less effect on lead hydronitride than on mercuric fulminate.

4. The lead plate tests prove that lead hydronitride in a lightly compressed state has about the same brisance as mercuric fulminite.

5. Lead hydronitride shows, in comparison with mercuric fulminate and the fulminate-chlorate mixture, a great superiority as an initiator of detonations.

6. Under heavy pressure, lead hydronitride retains its brisance unimpaired and does not exhibit the phenomenon of becoming "dead-pressed," while mercuric fulminate loses its brisance under comparatively light pressure and does become "dead-pressed."

7. Lead hydronitride, in spite of its superior qualities as an initiator of detonations, owing to its smaller development of gas, produces a somewhat smaller cavity in the lead block test than pure mercuric fulminate, and a much smaller cavity than the mercuric fulminate-chlorate mixture.

8. Lead hydronitride shows absolute insensibility to the action of moisture, is not hygroscopic, retains its brisance unimpaired with 5% of moisture, having retained it when stored continuously for 900 days in a moist atmosphere, while mercuric fulminate and its mixture with chlorate are rendered ineffective by 1% of moisture or by storage for 30 days in a moist atmosphere.

* * *

THE TRAVEL OF A PROJECTILE IN AIR AND ITS SIGNIFICANCE IN DESIGN

Translated from the German for the Journal of the United States Artillery by 2nd Lieutenant Lee R. Watrous, Jr., Coast Artillery Corps.

In the March number of *Streffleur's Militarische Zeitschrift* were discussed the phenomena that occur during the travel of the projectile in the bore of the gun, and the conditions under which the projectile leaves the bore and enters the air.

We shall now attempt, in what follows, to show how the passage through the air occurs—on the one hand, what influences affect the travel of the projectile; and, on the other, what measures, if any, may be taken to counteract them. In conclusion, we shall mention certain historical facts which will aid one in understanding the evolution of projectiles.

Were the projectile not acted upon by gravity and moved in vacuo after leaving the muzzle, it would, as is well known, continue its motion without any diminution of velocity to infinity, in that direction which the axis of the piece had at the moment of departure. But we know that there come into action forces which divert the projectile from its theoretical path and rather quickly consume its initial energy. As such forces, we recognize first, gravity; second, resistance of the air.

How, then, do these forces exercise their influence upon the motion of the projectile?

The first to be considered will be gravity (see Fig. 1). Were gravity not to act, the projectile, as we have already mentioned, would move in a straight line; for example, in x seconds, it would reach B. But during the entire time it is in motion, it is subject to the laws of falling bodies, which cause the projectile to fall, for example, from B to D.

Fig. 2 shows the significance of what has just been stated. For example, consider one projectile which, in a given time, has traveled as far as B_1, and at the same time has dropped the distance B_1D_1; then consider another projectile which, in the same time, has traversed a greater distance and fallen an equal height, B_2D_2; the trajectory of the second projectile has deviated less from the line of departure than the first and is, therefore, flatter.

Next, let us consider the question of the resistance of the air.

This is due to the fact that the projectile, in its rapid flight, must displace the particles of air in its path; this causes waves and whirls, like eddies one may see in moving masses of smoke or in waters near bridge piers; and these waves and whirls cause changes in air density.

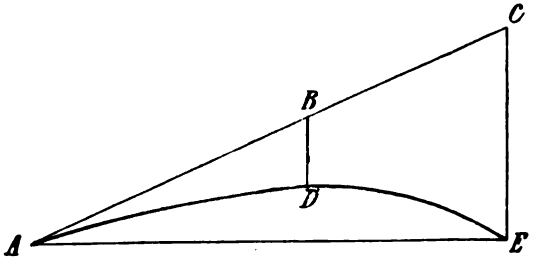

Fig. 1. 1420

AB = line of departure.
BD, CE = the heights of fall corresponding to the points B and C.

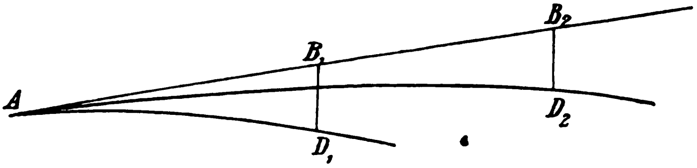

Fig. 2. 1430

$B_1 - D_1 = B_2 - D_2$

Now what influence has the resistance of the air upon the flight of the projectile? Were there no air resistance, but only the force of gravity, the trajectory would be, as is well known, a parabola whose maximum ordinate would be at mid range. The ascending and decending branches would be equal; the angles of departure and fall would be equal; and the initial and final velocities would be equal.

If, now, the resistance of the air be considered, its first effect is seen in the diminution of velocity of the projectile; in the cartridge Model 93, for example, of which the initial velocity is 620 meters per second, the remaining velocity at a distance of 300 meters is 443 per second, a loss in velocity of 177 meters per second.

As a result of the loss of velocity, there is to be expected a considerable reduction of the range in air, as compared with that in vacuo. The angle of departure for 2000 meters in air corresponds to a range of 6220 meters in vacuo, the projectile losing 68 per cent in range; and in the case of 2600 meters in air the corresponding range in vacuo is 10,228 meters, the loss in range amounting to as much as 75 per cent.

With the loss of velocity, energy also decreases; for example, with a muzzle energy of 307.7 m.-kg. the remaining energy at 300 meters is only somewhat greater than 158 m.-kg.

Since the travel of the projectile along the line of departure in a given interval of time is constantly decreasing, while the height of fall is constantly increasing, there results an ever increasing curvature of the trajectory. Hence, in every trajectory in air the descending branch has a greater curvature than the ascending branch; so the maximum ordinate is no longer at mid range, but nearer the point of fall, and the angle of fall is greater than the angle of departure. The resistance of the air, therefore, is the force to which is due the difference between the trajectory in air and the trajectory in vacuo.

Air resistance has, however, this advantage: it is the force that keeps a rotating oblong projectile approximately in the direction of the tangent to the trajectory; for, without this resistance, an oblong projectile, because of its rotation about its longer axis, would, in the latter part of its flight, maintain a motion parallel to that axis and would not strike the target point foremost.

A further explanation of those matters, however, would carry us beyond our subject. We are mainly concerned here with the phenomena attendant upon the motion of a projectile in air which have a definite effect upon hitting, the main object of shooting. That effect, so far as the gun is concerned, is controlled by the rifling and means of sight correction. The effects of wind, temperature, etc., are not regarded in this discussion.

Accurate knowledge of the phenomena which occur in the vicinity of a projectile moving in air, is not of long standing. Professor Ernst Mach in Prague and Vienna in the eighties of the last century first devised a method which makes it possible to photograph a projectile in flight, together with the surrounding air. By the use of his method, there is made visible the behavior of the air in connection with the high velocities of projectiles.

This method of photographing projectiles in flight has become of special significance in determining the laws of air resistance; it enables one to recognize the advantages or disadvantages of new shapes of projectiles, etc., and so is an important aid in their design. Moreover, regarded from a standpoint of pure science, the method is of signal importance. Therefore, it appears only proper that we at least causally glance at it.

How did Mach succeed in photographing the air? Though air is transparent, yet bodies which do not give off light, as do sources of light, still become visible when from them light is either reflected or refracted. Water in water is invisible; likewise, air in air. But if one pours water into alcohol, one sees film-like surfaces of alcohol spreading upon the water. The reason for this is, that water and alcohol have different refractive indices. In the same manner, air masses superimposed upon the surrounding air and having a different refractive index from that of the surrounding air can be recognized by the eye, or, in other words, can be photographed.

This visibility of the air is, indeed, a frequent and well known phenomenon which occurs where air masses are partially heated; the air masses ascend and expand, changing their density, and thus have other refractive conditions than the air surrounding them and thereby become visible. Marksmen, shooting over a [illegible] [illegible] heated, and his seeing the air, this shimmering, most inconvenient in aiming.

But to the camera changes in air density are far more evident than to the human eye. The moving projectile causes, in its vicinity, changes that

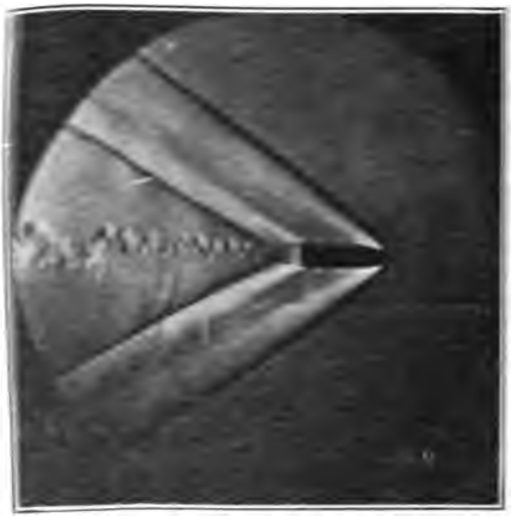

FIG. 3. 1431

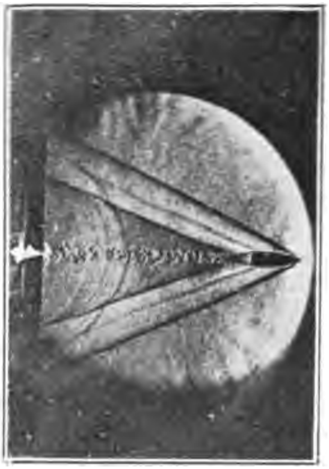

FIG. 4. 1432

may be photographed. Mach made use of particular apparatus for this purpose, further explanation of which we may omit.*

The basis of his method consists in electrically illuminating the moving projectile as it passes in front of a photographic lens. In this way is obtained an instantaneous photograph of the moving projectile and the atmosphere that surrounds it.

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* Additional simple explanations as to the method of photographing moving projectiles may be found in the work *Ausgewählte Kapitel der Technik* von Viktor Ritter v. Niesiolowski-Gawin.

Fig. 3 shows a photograph of an ogival headed projectile in flight.

The well known phenomena may be recognized: at the point of the projectile there is a well defined wave of compression, the so-called headwave; also, waves of compression are spread out from the projectile's surface, caused by the motion of rotation given the projectile by the rifling in the bore; from the base of the projectile there is a tail wave; and in rear of the base one sees whirls. Just behind the base of the projectile, one finds a rarefied air space that exercises a retarding effect upon it.

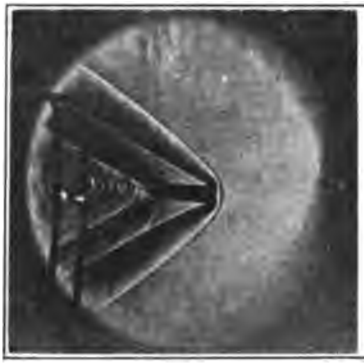

FIG. 5.

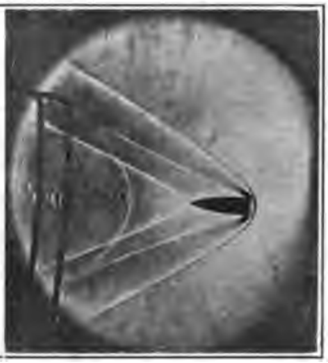

FIG. 6. 1433

Looking at Fig. 4, a picture of a moving "S" bullet, one sees, in general, the same phenomena as in the case of the ogival headed projectile. The only difference is seen in the smaller angle of inclination of the head wave towards the axis of the bullet, a result of the bullet's greater velocity.

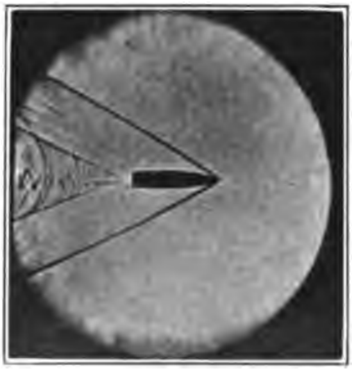

FIG. 7. 1131

The angle of the head wave, with reference to the axis of the projectile, can thus be made use of in the determination of the velocity.

In the case of a projectile fired point to the rear (Figs. 5 and 6), there is, besides a strong pushing out of the air in front, a lesser formation of whirls behind its point. This may give rise to the idea that a projectile with a pointed base travels better than one squarely cut off. To be sure, a part of the energy of the projectile is used up in forming these whirls and in encountering the changes in air density resulting from them; were these reduced, there would, of course, be an increase in the remaining velocity. But such double pointed projectiles have shown themselves to be very unstable, so that one cannot consider their adoption. However, a projectile such as the French "D" bullet (see Fig. 7), having a slight taper at the base, has shown very favorable ballistic qualities. But it must be distinctly understood that the flatness of the trajectory obtained, was not the result of the tapering alone.

It would be very erroneous to assume that, in the case of the present infantry bullet and powder, it would be practicable to obtain greater flatness of trajectory, with resultant increase in precision, merely by increasing the muzzle velocity. Assuming that the weapon and the rifleman (the latter especially, in the matter of recoil) can stand an increase in muzzle velocity, there is, nevertheless, but little gained. For, with an increase of muzzle velocity, the resistance of the air considerably increasing, the gain in flatness of trajectory is little, and in no way proportional to the disadvantages which an increase of muzzle velocity brings to the rifleman and the weapon. Of course, the muzzle velocity of a rifle is in no case so great but that by its increase we should gain additional flatness: in the case of a normal projectile, with a muzzle velocity of 620 meters per second, for a range of 600 meters the height of trajectory at 400 meters is 2.4 meters; taking, now, the same projectile with a muzzle velocity of 700 meters per second and the same range, the height of trajectory at 400 meters is about 1.8 meters, or about 60 centimeters less. But such an increase in the muzzle velocity, with the present powder and heavy projectile, would very markedly raise the gas pressure in the weapon, thereby affecting unfavorably the weapon and the marksman.

For obtaining flatness of trajectory, in addition to an increase of muzzle velocity are to be considered the following: a favorable form of projectile for most easily overcoming the resistance of the air; a sectional density that will prevent a too rapid loss of velocity; and a suitable velocity of rotation about the axis, which will cause the projectile in going through the air to take up a position of least resistance, that is, in the direction of the tangent to the trajectory.

Keeping the present minimum weight of projectile at 10 grams, a muzzle velocity between 800 and 900 meters per second may be considered the outside limit, since, beyond this, not much can be gained in flatness of trajectory. With this as a basis, we will now take up the significance of the pointed bullet.

The chief characteristics of pointed projectiles are, in general, their lower weight and their more or less tapering point.

The projectile should not have a too rapidly tapering point because of reasons of manufacture, because of liability to deformation, and because of difficulties of insertion in the cartridge case. A slight rounding off, with a radius of about five millimeters, removes these difficulties without unfavorably affecting air resistance.

As regards ballistic qualities, one can, in general, divide these bullets (excepting special projectiles of various designs) into two general classes: (a) light projectiles (about 10 grams), characterized by high muzzle velocity (exceeding 800 meters per second) and great flatness of trajectory in the beginning; these, however, because of their small mass, lose relatively fast in velocity and, therefore, in flatness of trajectory (for example the German "S" bullet); (b) heavier projectiles (about 12 grams) of somewhat less muzzle velocity (under 800 meters per second) and less flatness of trajectory in the beginning; these, on the other hand, lose velocity less rapidly and have somewhat flatter trajectories at greater ranges (for example, the French "D" bullet).

Now let us consider these two classes somewhat more in detail and in comparison, as to ballistic qualities, with the cartridge of Model 93 (15.8 grams). (See Fig. 8, a graphic representation of velocities at various ranges.*)

For this purpose, for each of the projectiles mentioned, the ranges and corresponding velocities are plotted and the points connected. Their characteristic curves show the remaining velocities at the various ranges.

The remaining velocities, in the case of the "S" bullet, decrease somewhat rapidly for ranges up to about 1000 paces; beyond that distance, their rate of loss is somewhat slower. The "D" bullet (French), however, shows a similar loss of velocity. The projectile Model 93 loses rapidly in velocity in the beginning, like the "S" bullet; but from 500 paces on, the loss of velocity, with increase of range, is slower, as in the case of the "D" bullet.

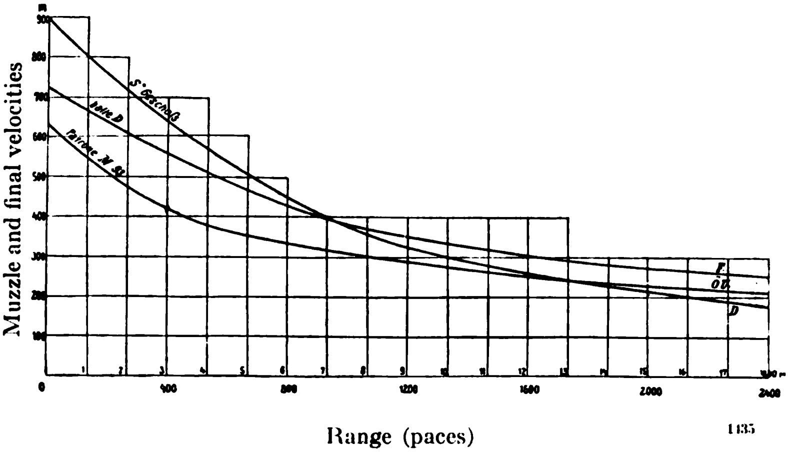

FIG. 8.

The causes of these various phenomena are numerous.

The high muzzle velocity of the "S" bullet is due, principally, to its low weight and its powder; the rapid loss of velocity is primarily a result of its small mass (its sectional density is about 20 g.-cm.^{2}) and its high muzzle velocity: the air resistance increases with the velocity in much higher ratio than simple proportion, which the small sectional density cannot overcome. On the other hand, if the velocity of the projectile has fallen off a certain amount, as for example at 1000 paces, then the sectional density, with reference to the air resistance, stands in a far more favorable ratio; hence a less rapid loss of velocity. The fact that the projectile shows steady flight, is due to its higher muzzle velocity, greater rotational velocity, rifling of the piece, and favorable point.

The "D" bullet shows throughout its travel a uniformly decreasing velocity, approximately proportional to the range. The French bullet has, however, relatively to the other pointed bullets, a much greater length, 39.2 mm. (the German is 28 mm.); the reason for this is that, on account of the French rifle barrel, the choice of material for the bullet is limited: the material consists of an alloy of 90 per cent copper and 10 per cent zinc, which is light; and this forced the construction of a long bullet. On account of the greater weight of the projectile, the muzzle velocity is essentially smaller (720 meters per second). Since, on the one hand, the air resistance is less and, on the other hand, the weight and form are favorable, there follows a gradual, better regulated loss of muzzle velocity.

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* Taken from the essay *Moderne Gewehrpatronen* in the pamphlet *Aus Vorträgen an der k. u. k. Armeeschiessschule über Waffenwesen.*

At about 900 paces, the "S" bullet and the "D" bullet have similar velocities. Beyond 900 paces, the conditions are more favorable for the "D" bullet.

The exceptional projectile length may well awaken fear that the bullet, due to the influence of the resistance of the air, may have a strong inclination to turn base foremost, so as to obtain a more favorable position for its center of gravity. Due, however, to its rear tapering, the center of gravity is moved to the front, so that there is little fear of this happening.

In the cartridge Model 93, the velocity falls off rapidly up to about 400 paces; and then, as in the case of the "D" bullet, it falls off slowly and fairly regularly. The reason for this lies in the form of the projectile's point; for although, as a consequence of a reduced muzzle velocity and a large sectional density, a rapid falling off in velocity ought not to take place, yet an unfavorable head tends to stop the projectile. Only after a loss of some of its already low initial velocity does the projectile's weight make itself favorably felt in preventing further loss: the favorable influence of weight then outweighs the unfavorable influence of form.

We demand, in general, that a projectile shall encounter the least possible resistance of the air. This requires that it shall expend a minimum of its given energy in overcoming air currents and changes in air density. This depends upon: (a) the caliber, the muzzle velocity, and the rifling suitable for the length of projectile adopted; (b) the muzzle velocity demanded, having reference to favorable form; (c) upon the length of the bore; (d) complete symmetry of the projectile; and (e) proper projectile material.

To take up all these points in detail, would go beyond the limits of this paper. But it must be borne in mind that, from a ballistic standpoint, the question of the weight of the projectile is the most difficult to solve.

However, that requirement soon finds a limit, depending as it does on: (a) proper regard for satisfactory flatness of trajectory; (b) permissible recoil of the weapon; (c) length of the projectile; (d) the length assumed, having regard for favorable form of point; (e) the maximum number that can be carried by a man. But, of these, only the effect of the form of point will be discussed.

As experiments have shown, it is, in general, desirable that in a given length of projectile the point should be made as tapering as possible. The length of the point, however, is limited, having regard for the stability and weight of the projectile, and, moreover, for sufficient length of body; although this consideration enters but little, on account of the sharper twist of the rifling.

In what precedes has been noted the flatness of trajectory of long pointed projectiles.* Those projectiles as compared with ogival headed projectiles show, also, a far greater accuracy; and this accuracy depends on the causes of dispersion. But the causes of dispersion, with reference to their direction (and partly to their intensity), in so far as they depend upon the weapon, the marksman, and the cartridge, disregarding special circumstances, are, in general, the same, when shooting with one and the same weapon the pointed and the ogival headed projectiles. The greater accuracy, therefore, lies principally in the greater steadiness in flight of the pointed projectile and its shorter time of flight. We know that the dispersion increases with the range, and the vertical dispersion in somewhat higher ratio than the range. If, therefore, over a given range the time of flight is shorter (as in the case of the pointed projectile), then the influences that cause dispersion acting for a shorter time produce less effect, i.e., the dispersion is less.

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* For the practical importance of flatness of trajectory, see the essay *Uber Rasanz* in the *Mitteilungen der k. u. k. Armeeschiessschule* 2. Vierteljahr, 1910, Streffleur, Maiheft.

If one now asks, How should a type projectile be designed to achieve ballistically the most favorable results? one cannot give an exact reply, although in designing projectiles there are general principles to be depended upon which give the proportions of a bullet. These, however, in particular cases must be modified by experiment. Every type of rifle calls for a definite type of bullet which, for this particular weapon, promises the best results. Experiments have shown that a bullet which, with a particular rifle, gives very good results, with another similar model of rifle, fails.

The present modern infantry projectiles show, as their main characteristic, the slender point—a result of the striving for a flat trajectory. But this can be obtained only with projectiles whose form, in connection with their required muzzle velocity, is able to overcome air resistance more easily than formerly.

The question now arises, Why did we come so late to a knowledge of the value of the form of the pointed projectile, after it had been introduced?

To answer this question, we must review the state of knowledge concerning projectiles shortly before the introduction of small calibers.

Before the introduction of 8 mm. guns, 11 mm. and even larger caliber guns were in use, large lead bullets and black powder being used with them. Their muzzle velocity was low. The introduction, at the end of the eighties, of the long (about 8 calibers), jacketed bullets, with their cylindrical ogival form and increased muzzle velocity, indicated a great ballistic advance. The authorities, as for example Plönnies, men of great influence, still taught that the ballistic properties of the rifle bullet depended primarily upon its travel in the bore; that the influence of the point of the projectile, no matter what possible shape it might have, was little. This was the point of view about forty years ago, and, with reference to the form of the projectile, up to about twenty five years ago. The large calibers demanded short bullets, 1-½ and at most 3 calibers, so as to have proportionally light projectiles, considering the increased gas pressure—recoil and demands made upon the weapon—and disregarding the difficulties involved in the rifling. Trajectories, prior to the first steel jacketed bullet, were generally very curved. The velocity of rotation, because of the soft material used in making bullets, was necessarily low; therefore, the stability of the bullet, especially at the greater ranges, was only moderate and the accuracy still less. That it traveled at all was due to its mass and the good position of its center of gravity.

The form of the points made use of at that time, because of their shortness, could in no way influence the existing trajectories, except at the shortest ranges. In this way, may be explained the views here mentioned relative to the form of point which have lasted to present times.

Investigation showed that the advantage of the tapering point of the bullet first became evident when the length of the point, in proportion to the caliber, was considerably greater than the latter and when the bullet was given a higher muzzle velocity. These bullets demanded, relatively, a greater length and, on account of their unfavorable center of gravity, a sharper twist in the rifling. These, however, as we have seen, were not possible before the use of fixed ammunition; therefore a reduction in caliber had first to occur in the development of projectiles.

Why, however, at the same time that small calibered fixed ammunition came in, the questions relative to the point did not arise? may now be asked. It is plain enough that a smaller caliber, better powder, greater muzzle velocity, and increased length of bullet, were such tremendous advances that it could hardly be expected that there should be experiment with new forms of point, of which the small influence on the motion of the projectile was unquestioned.

Even if, at the time of the introduction of the first 8 mm. bullets, the long pointed projectile had been considered, it would hardly have met with favor; for the tendency of the bullet to turn base foremost, so as to place its center of gravity in a more favorable position (that is, in front of the center of figure), was clearly recognized. Indeed, the long pointed bullet of the present day, in spite of advantages, is still subject to the disadvantage of an unfavorable position of its center of gravity.

At that time, with the lower muzzle velocities, the air resistance was not so great, so that the definitely pointed projectile, as compared with the ogival headed projectile, would not show forth any advantages. Attempts had been made to fire pointed projectiles with low muzzle velocities, and the results had been unfavorable as to ballistic qualities. The high velocities which brought out the advantages of the pointed bullet were only achieved in more recent times, and then there were no further obstacles in the way of the pointed bullet.

To be sure, further developments will not cease. More effective powders —not stronger, but better adapted to the travel of the projectile in the bore— may give better results.

What increased efficiency may yet be introduced through changes in form and material of projectiles, cannot be predicted; nor, indeed, that the desired result will not be brought about by moving the center of gravity as far to the front as possible, cannot be stated. But that the Mach method of photographing flying bullets, together with measuring still air resistance, will point the way to correct principles of projectile design may be confidently expected.—*Streffleurs Militarische Zeitschrift.*

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ANTI-EROSION COATING FOR PROJECTILES

The object of this coating is to prevent erosion by eliminating contact between the surface of the projectile and the surface of the bore during travel in the bore. It is not a lubricating, but a plastic substance, such as silicate of soda, alone or mixed with powdered clay. Adhesion of the substance is increased by roughening the surface of the projectile, chemically or mechanically. Without such precaution, the coating might be stripped off by the rifling. The treatment, it seems, is giving good results.—*Revue d'Artillerie.*

CONCERNING THE INCREASE OF THE VELOCITY OF A PROJECTILE AFTER LEAVING THE MUZZLE[*]

By M. Okochi

Translated from the German for the Journal of the United States Artillery by Lieutenant Lee R. Watrous, Coast Artillery Corps

I. INTRODUCTION

The velocity of a projectile at the instant it leaves the muzzle, is a very important element of interior, as well as exterior, ballistics. If one speaks of the velocity in the bore, the muzzle velocity is the final velocity; while, from the standpoint of exterior ballistics, the muzzle velocity is the initial velocity.

The muzzle velocity of a projectile is determined usually with the Boulengé Chronograph. This apparatus measures the interval of time between the breaking of two circuits: the projectile passing through a screen close to the muzzle, breaks one circuit, thereby letting fall a long rod, which is held by an electro magnet; fifty to 100 meters distant, another screen is passed through, this breaks the second circuit and releases a small rod, which in turn, causes a knife edge to make a mark on the falling long rod; the mean velocity is determined from the time so measured; from this mean velocity, the muzzle velocity is calculated by any of the laws of air resistance.

Many investigators have asserted that this method of measuring the muzzle velocity of a projectile is not exact, because the powder gas, pouring out of the muzzle, continues to accelerate the projectile when some meters distant. This phenomenon was first observed by Crehore and Squier[†] with their "Polarizing Photochronograph" at ten different points along the trajectory. The results of their investigations showed that the mean muzzle velocity of projectiles, fired from 3.2 inch field pieces, was 488 m.-sec., and that the velocity six or seven feet, or twenty five calibers, from the muzzle, possesed a maximum value 2.5 per cent greater than the velocity at the muzzle.

A. Indra[‡] has worked out empirical formulas for the increase of the projectile's velocity, based upon the results obtained with the Boulengé Chronograph, and has proved that the powder gas has an accelerating influence at a very great distance from the muzzle.

M. Radacovic[§] observed the loss in velocity of a projectile, with the condenser-chronograph. The great advantage of his method of measuring lies in the fact that extraordinarily small intervals of time may be determined; but it offers more or less difficulty in the careful insulation of the apparatus and permits measuring at only one place along the trajectory. Radacovic's experiments showed the velocity greatest at the muzzle, decreasing to a point at a distance of 75 cm., then increasing to a point 165 cm. from the muzzle, where it attained a second maximum velocity, which is, however, smaller than the muzzle velocity.

At the German proving grounds for rifles, at Halensee near Berlin,[||] other investigations with the infantry rifle Model 88 and service ammunition have been made. According to these, the maximum velocity occurs at a point three meters in front of the muzzle; while in the experiments of Minarelli[¶]

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[*] Translation of a pamphlet published by the Tokyo Mathematico-Physical Society, which was in turn a reprint from *Tokyo Sugaku-Buturigakkwai Kizi*, 2nd Ser., Vol. VII, No. 6.

[†] A. C. Crehore and G. O. Squier, *The Polarizing Photochronograph;* New York, 1897.

[‡] A. Indra, *Mitteilung. u. Gegenstande d. Artillerie u. Genie-Wesens.*

[§] M. Radacovic, *Sitzgsbr. d. k. Akad. d. Wissensch. in Wien*, 109 (1900), Abth. IIa.

[||] *Deutsche Versuchsanstalt fur Handfeuerwaffen*, M.u.G.d.A.u.G., 1900.

[¶] Minarelli Fitz-Gerald, ebenda (1901), p. 269.

with the 8-mm. repeating rifle Model 88-90, and bullet Model 99, conducted with a specially arranged ballistic pendulum, the maximum velocity was found 75 cm. in front of the muzzle, where, according to Radacovic, it should have its smallest value.

The investigations of W. Wolff* with the 8-mm. rifle and various charges, showed no increase in velocity after leaving the muzzle; that is, the velocity is highest at the muzzle and from there continuously decreases. Wolff measured the velocity at five points along the trajectory by means of an induced electric spark oscillating upon a rapidly revolving drum, the projectile making a record as it went through a wire screen in series with the primary circuit of the induction coil.

Since the results of the above mentioned investigations vary greatly, it does not seem useless to study more thoroughly the decrease of a projectile's velocity in the vicinity of the muzzle. This experiment attempts to ascertain the after effects of the powder gas in the Japanese 6.5-mm. Infantry Rifle, Model 98.

II. ORDER OF EXPERIMENTS

In the investigation of the decrease of a projectile's velocity near the muzzle, short sections of the path must be considered. Consequently, it is necessary to determine the mean velocity over sections not exceeding one meter at different distances from the muzzle for one and the same shot, the initial velocity of different shots varying as much as 3 per cent.

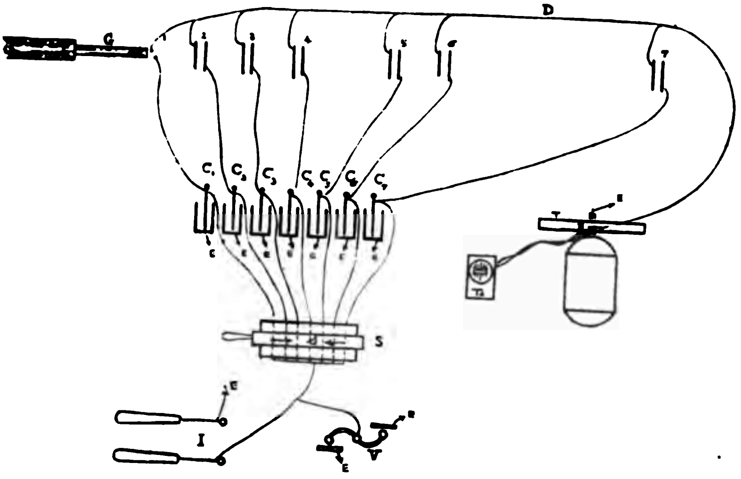

FIG. 1.

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In the present investigation, a sort of drum chronograph, with a number of charged Leyden jars, was employed, instead of a spiral induction coil. The jars were so arranged that, simultaneously with the passing of the projectile through one of the targets, or screens, one of the jars was discharged, which let a spark strike on a common spark area on a rapidly revolving drum. By this method, the error of the peculiar retardation of every induction coil and of the relative position of different spark areas could be eliminated.

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* W. Wolff, *Kriegstech. Zft.*, VIII Jahrgang (1905), p 481.

The scheme of the whole experimental apparatus is shown in Fig. 1.

The first screen, 1, just in front of the barrel, G, consists of two thin copper wires. The forward wire is connected with the inside of the condenser, C_1, whose outside is grounded, while the rear wire is led to the spark area, F, through the carefully insulated wire, D. Both wires are so placed here, that the projectile as it leaves the muzzle, makes contact between them, and discharges the condenser. The interior of the condenser is also joined with the induction machine, I, through the switch, S.

Along the path of the trajectory in front of the muzzle, are six paraffin frames (2, 3, 4, 5, 6, and 7.) On both sides of these are very thin sheets of tin-foil, just about the length of the projectile from one another. All the forward sheets of tin-foil are connected to the inside of the condensers (C_2, C_3, C_4, C_5, C_6, and C_7) and then to the induction machine, through the switch; while the rear ones are connected by the wire, D, to the spark area. The switch, made of hard rubber, is provided with a sliding piece, which, in the position shown in Fig. 1, connects all the condensers with the induction machine. If, however, the slide be moved in or out, any condenser may be insulated. Before the shot is fired, the condensers are charged to a certain potential, which is measured by the voltmeter, V; the drum on the shaft of the motor is rapidly revolved; the switch, S, is moved to a position insulating all the condensers; and the gun is fired. The projectile first bridges over the pair of wires in the screen; then, breaking through the sheets of tin-foil on the frames, 2-7, bridges them over and discharges the condensers, one after another. At the discharge of each condenser, a spark jumps upon the paper covered with lamp-black which is wrapped around the rapidly rotating drum. The number of turns per minute of the drum is measured by the tachometer, Ta, and the distances between the spark marks on the paper strips determine the elapsed times of the projectile's flight over the sections of the trajectory considered.

III. SOURCES OF ERROR

The position of the projectile relative to the paraffin frames at the instants of electric discharge, may be different, as the discharge potentials of all condensers are not the same. It happens many times that the first condenser will be prematurely discharged by the hot gases, while others, on account of small oscillation, remain completely inactive. One can avoid this first premature discharge by tightly stretching the wires. It may be assumed that the variation in the position of the projectile relative to the frames at the moments of electric discharge, amounts to 1 mm. or less; the error then introduced will be less than .1 per cent in the case of a 1-meter section of trajectory, which was used in the experiments by K. Becker and C. Cranz* in investigating the air resistance of projectiles.

This error is smaller than in the case of the drum chronograph with the induction spool; for with that, must be taken into consideration the penetration of the head of the projectile between the wires in going through, and the lengthening of the wires before the tearing of the screen.

Next, may be asked, Is the variation of the spark mark, due to the spark's not jumping straight, sufficiently small for the measuring of the time interval? W. Wolff† has decided that it will amount to less than .3 mm. if the rotational velocity of the drum is 42 m.-sec. and the spark area very small. In our case, the rotational velocity was about 34 m.–sec., measured with the Hartmann-Kempfschen tachometer, with no retardation of the induction current occurring. Therefore, one may conclude that the variation is less than .2 mm. The errors involved amount to .4 per cent for a spark marked distance of 5 cm. This distance corresponds to the velocity of rotation under consideration, a trajectory section of 1 m., and a projectile velocity of 700 m.–sec.

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* K. Becker and C. Cranz, *Artilleristische Monatshefte*, Nov., 1912, p. 333.

† W. Wolff *l.c.*

The tachometer allows the number of revolutions per minute in multiples of ten from 1940 to 2060, to be counted with sufficient accuracy.

The definition of the spark marks on the soot-covered paper was very satisfactory, it being possible to measure the distances between the marks to one one-hundredth of a millimeter with the Cambridge Instrument Co's micrometer. Therefore, one could measure to 3×10^{-7} seconds.

What loss of velocity the projectile sustains because of cutting through the tinfoil sheets, has been mentioned by other authors* so we do not need to consider it.

IV. RESULTS OF INVESTIGATIONS

Beyond the first screen, made up of two wires and just in front of the muzzle, stand the paraffin frames (2, 3, and 4) each separated from the preceding by 50 cm.; 1 m. from the 4th is the 5th; 50 cm. from this, the 6th; and 2.5 m. from the 6th, the 7th. From the time of the projectile's flight between the frames 1-3, 1-4, 1-5, 2-5, 2-6, 3-6, and 6-7, we obtain the mean velocities for points .5, .75, 1.25, 1.50, 1.75, 2.00, and 4.25 meters respectively from the muzzle. The corresponding sections of the path are 1 m., 1.5 m., 2.5 m., 2 m., 2.5 m., 2 m., and 2.5 m. in length. These velocities are tabulated in the table on the following page.

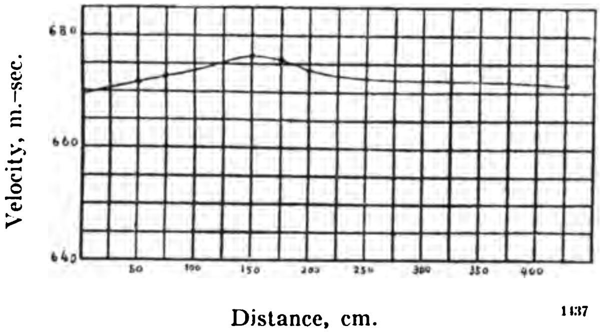

Fig. 2.

The mean value of the 12 shots is shown graphically in Fig. 2.

The velocities observed 1.25 m. from the muzzle, seem to have averaged too small. This occurred because, for the velocity of the projectile, it being still quite small in the vicinity of the muzzle, too large a section of path was selected. The maximum velocity is at 1.5 m. from the muzzle in the I, VI, VIII, X, and XII shots; at 1.75 m. in the II, IV, V, VII, IX, and XI; while in the III it is at the muzzle. In the II, VI, XII, and VII shots, we see the phenomenon observed by Radacovic; that is, the minimum velocity between the distances of .75 and 1.25 meters.

The action of the powder gas upon the projectile at the muzzle, has been investigated by the Töplerschen Schlieren method, using electrical instantaneous photography.

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* K. Becker and C. Cranz, *l.c.*

In the 1st photograph, Fig. 3, the base of the projectile is about 2.5 cm. from the muzzle. A is a copper wire inclosed by a glass tube; M, the muzzle of the barrel. One recognizes several air waves. The one close by the muzzle, W_1, is the explosion sound wave. At the muzzle are seen some other waves with a greater radius, whose center must lie approximately in the axis of the piece: these have no significance in our experiments. W_3 is the air wave pushed out of the barrel by the projectile.

Schuss Nr.	$V_{0.5}$	$V_{0.75}$	$V_{1.25}$	$V_{1.50}$	$V_{1.75}$	$V_{2.00}$	$V_{4.25}$	Tourenzahl pro Min.
I	666.7	667.6	670.9	672.8*	670.4	668.4	661.2	2020
II	661.1	662.3†	661.1	669.2	672.7*	670.9	663.9	1980
III	668.3*	664.6	663.6	661.6	661.0	660.1	659.0	1980
IV	667.8	671.2	676.0	676.8	681.0*	677.7	677.6	1980
V	672.7	673.0	673.7	678.9	679.1*	675.3	674.0	1980
VI	673.8	670.6†	672.2	676.6*	676.1	671.8	669.5	1980
VII	678.3	676.2	675.6†	679.9	681.2*	677.8	678.0	1980
VIII	675.1	679.4	678.0	679.7*	678.1	678.1	674.2	2000
IX	678.6	680.9	681.6	681.3	686.1*	681.5	676.9	1960
X	670.8	676.9	676.7	679.2*	673.5	672.3	669.3	1990
XI	670.1	676.0	675.7	676.2	678.2*	675.4	669.0	2000
XII	675.3	673.5†	676.5	679.3*	672.2	672.4	673.3	1960
Mittel	671.80	672.68	673.72	676.19	675.82	673.73	671.16	

The * marks the maximum value in the series, while the † indicates the minimum value.

In the 2nd and 3rd photographs, we recognize further developed phases. The explosion sound wave in the 2nd photograph consists of two concentric spherical waves; the projectile is enveloped by powder gas at about 8 cm. from the muzzle. The propagation velocity* of this sound wave is calculated as about 550 m.-sec. (similarly the one in the 3rd photograph as about 552 m.-sec.), if one takes the muzzle velocity from the tables as just averaging 670 m.-sec. The middle point of the explosion wave lies along the axis of

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* According to E. Mach, this velocity increases to 700 m.-sec. with strong primers. C. Cranz asserts that it amounts to 760 m.-sec. with automatic pistols. See E. Mach, Sitzb. d. k. Akad. d. Wiss. 75 (1877), II. Abth.; C. Cranz, Anwendung der elektrischen Momentphotographie, p. 21; W. Wolff, Ann. d. Phys. 69 (1899).

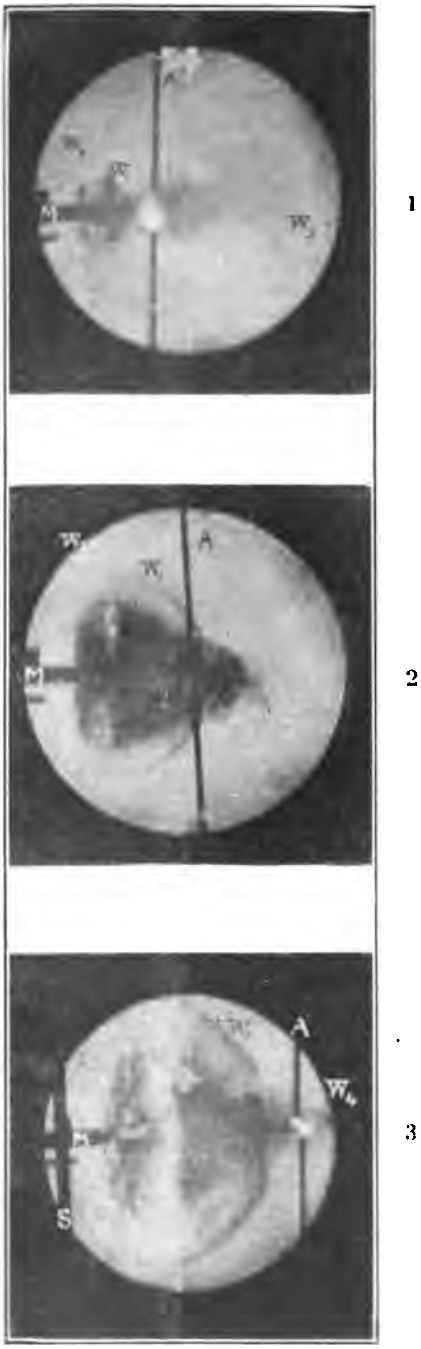

FIG. 3. 1435

the weapon, about 2.4 cm. from the muzzle (in the 3rd photograph about 2.5 cm.).

In the 3rd photograph, where the base of the bullet is about 12 cm. from the muzzle, we observe that the bullet-formed sound wave is conical pointed, W_4, in front, due to the streaming forth of the gases, which are traveling at a much greater velocity than the projectile. This conical wave must not be confused with the head wave of the bullet: it is rather to be considered a head wave of the expanding gases. We can recognize very plainly the gas clouds pouring out at a greater velocity and surrounding the projectile, whose velocity, therefore, they must increase.

Now, if half the conical angle a and the velocity of propagation c of the explosion wave in the photograph are measured, the velocity u, at which the gas pours out, with its resulting relations, may be calculated:

$$u = \frac{c}{\sin a}$$

In the 3rd photograph, $a = 25° 30'$ and $c = 552$ m.–sec.; therefore, $u = 1277.5$ m.–sec.

The velocity at which the powder gas pours out, can be calculated in a similar manner from the increase in velocity of the bullet in front of the muzzle.

According to the velocity diagram, Fig. 2, the increase in velocity, just in front of the muzzle amounts to 1 m.–sec. for sections of 25 cm.; from this is obtained the accelerating force which acts on the bullet (disregarding air resistance):

$$mv\frac{\Delta v}{\Delta x} = 2.877 \text{ kg.}$$

where m stands for the mass (weight of projectile 10.5 g.) and v the velocity of the projectile. Now, if we consider that the projectile remains in a fixed position and that on its base the powder gas pushes with the relative velocity $u - v = u_r$ in a direction coinciding with the long axis of the projectile, we obtain from the general law of air resistance,

$$mv\frac{\Delta v}{\Delta x} = k\pi R^2\frac{\delta}{\delta_0}f(u_r) \qquad (1)$$

where k is a constant, R the radius of the projectile in centimeters, δ the specific gravity of the powder gas in kg.–cu. cm., and δ_0 that of the normal air.

To determine the specific gravity of the powder gas, at the instant in question, offers many difficulties. Nevertheless, as in the case of interior ballistics, where it is expressed as a relation between the weight of the charge and the volume of the powder chamber, we can calculate it from the photograph of the space which the powder gas takes up in front of the muzzle and the computed volume of the bore.

The volume of the heart shaped gas cloud in the second photograph is 521.4 cu. cm.; that of the bore, 30.2 cu. cm.; and and the weight of the charge is 2.07 g. Therefore we obtain:

$$\delta = 3.753$$

We shall depend upon the well known investigations of air resistance to cylindrical projectiles for what concerns the values of k and $f(u_r)$.

According to K. Becker and C Cranz* the air resistance of a cylindrical projectile (dia. 8 mm., weight 10 g.), will be expressed by the formula:

$$k\int(u_r) = u_r^2\, k\,(u_r)$$

with $10^6\, k\,(u_r)$ 7.83, 7.78, 7.72, 7.65, 7.53; for u_r m.–sec. 650, 625, 600, 575, 550, where $\delta_0 = 1.22$.

If we introduce the numercial value of the accelerating force in equation (1) and solve for the corresponding values of u_r and $k\,(u_r)$, we obtain, after repeated computations, $u_r = 605.0$ m.–sec. for $k\,(u_r) = 7.7 \times 10^{-6}$. From this we obtain for the velocity of the gas pouring out in front of the muzzle:

$$u = u_r + v = 1275.0 \text{ m.–sec.}$$

which coincides almost exactly with the value determined from the photograph. This coincidence is, of course, accidental; for a photograph not shown here, produces, with $\delta = 2.510$, $u = 1409.9$ m.–sec.

If the velocity of the gas pouring out does not exceed the velocity of sound, the velocity of sound can be calculated from the formula for static out-pouring of gas, namely:

$$u^2 = v^2 + \frac{2\,gk}{\delta(k-1)}\, p_m \left[1 - \left(\frac{p}{p_m}\right)^{\frac{k-1}{k}}\right]$$

where k is the specific heat constant; p_m. the muzzle pressure; p, the atmospheric pressure; and v, the muzzle velocity. In the present case, however, this is not true.

CONCLUSIONS

The results of the preceding investigations may be condensed in the following sentences:

We cannot detect the head wave of the projectile, just after it leaves the muzzle, because the projectile lies in a medium which is moving forward. The powder gas presses on the base with almost double the velocity of the projectile; consequently the velocity of the projectile increases until the projectile meets the resistance of the air, when it commences to lose energy.

It is very probable that there is no minimum velocity between the muzzle and the point of maximum velocity; also that the steady decrease of velocity, after the projectile leaves the muzzle, occurs only in the case where the charge burns very quickly and the muzzle pressure is very low.

The maximum velocity of the projectile of the Japanese rifle, Model 98, occurs at a distance of about 1.5 meters from the muzzle. This is about .8 per cent greater than the muzzle velocity, which the projectile again has at about 5 meters from the muzzle.

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FUEL AND LUBRICANTS FOR INTERNAL COMBUSTION ENGINES

By B. H. Arnold

Erie Works, General Electric Company

As experience with internal combustion engines has been based to a great extent upon those of the widely distributed automobile and motor-boat types, the popular idea of gasoline is that of a fuel which can be successfully used in automobile and motor-boat engines. Until recently but little has been known of gasoline; and its low price and the fact that the majority of users purchased it in small quantities offered no incentive for its investigation. For many years previous to the advent of the gasoline engine, gasoline was a by-product in the manufacture of kerosene, and its disposal a problem to the refiner.

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* K. Becker and C. Cranz, *l.c.*

A. Mallock, Proc. of Royal Society 74 (1904) p. 267. He has measured the air resistance of the .311 inch cylindrical aluminum bullet with the ballistic pendulum.

Conditions are now reversed, for the large number of gasoline engines has created a big demand for gasoline and kerosene is being over-produced. This demand has increased the price of gasoline to such an extent that many engineering societies are investigating both engine design and petroleum refining with the idea of securing lower fuel costs.

Gasoline and its associate naphtha are generally known to be volatile, colorless and inflammable distillates of crude oil or petroleum, graded and sold by some gravity method, usually the Baumé scale. The higher a gasoline tests by this scale the more desirable it is supposed to be. This method of grading is, however, inaccurate and misleading, and where definite information is desired of the characteristics of any distillate, it must be superseded by the method based upon fractional distillation. If all other conditions were equal, the gravity method would be a fair means of comparison, but at the present time when these distillates are obtained from petroleum of many fields and having different characteristics, it is a fact that gravity by the Baumé or any other scale tells very little of the relative suitability of various gasolines or naphthas. In order to show the reasons for this and the meaning of fractional distillation, we will discuss briefly the antecedents of gasoline and naphtha, as well as their use. This discussion is to be considered under the following heads:

(1) Petroleum, Its Occurrence and Composition.
(2) Refining of Petroleum.
(3) The Use of Gasoline and Naptha in the Engine.
(4) Specifications and Purchase.
(5) Possibilities of Other Liquid Fuels.

(1) PETROLEUM, ITS OCCURRENCE AND COMPOSITION

The U. S. Geological Survey issues each year a bulletin containing complete figures in regard to the United States' production of petroleum and that of the last ten years of other countries. Those interested are referred to this bulletin, which will be supplied gratis by the survey.

Petroleum has been found in all parts of the world, without any definite scheme of distribution. An inspection of any map indicating the distribution of the world's known petroleum fields will show that practically all of the producing regions are in or near civilized communities. From this, it is believed that those regions not now producing contain much oil as yet undiscovered, rather than that these regions are barren, as some would have us believe. Regardless of recent newspaper comments on the decrease of the world's petroleum production, it is believed that while the production may not be increasing in proportion to the demand, the trouble is largely due to lack of transportation facilities and not to any immediate limitation of available source of supply.

Recently published articles have announced the discovery of large quantities of petroleum in various South American countries and of enormous quantities in North China. Mexico's world breaking records have been common property for some time. During the next two or three years the opening of the Panama Canal and the increase in number of tank steamers and pipe lines will make available these great supplies and have much effect on the price of crude oil.

Chemical analysis shows that crude oil is a very complex mixture of a large number of chemical compounds, which can be arranged in eight groups or series, two of which predominate in and characterize practically all petroleums. One of these series, called the Methanes or paraffins, predominates in certain petroleums known as the paraffin-base oils. This is a stable series of compounds of the general chemical formula C_nH_{2n+2}. The members as arranged in ascending values of "n" show a regular increasing specific gravity and temperature of boiling point. As an illustration of this series:

Methane CH_4 is a gas at ordinary temperatures and pressures.

Monane C_9H_{20} is a liquid down to 59 deg. F. (51 deg. C.) and has a boiling point of 300 deg. F. (150 deg. C.).

Nonadecane $C_{19}H_{40}$ is a solid at 89 deg. F. (32 deg. C.) and boils at 626 deg. F. (332 deg. C.).

Another series known as the olefines are characterized by the general chemical formula C_nH_{2n} and predominate in those petroleums known as the asphalt-base oils. Members of other series are also present, but in small quantities; therefore, we need concern ourselves with but the two series above mentioned. The members of both series are hydro-carbons and have similar structure and characteristics. Each member has its own specific gravity and boiling point different from those of any other in the same series. However, a member in another series may have either the same boiling point or the same specific gravity, but both specific gravity and boiling point will not be the same.

The most important practical distinction between distillates obtained from different oils is that the distillates derived from the asphalt-base oils at the same boiling point are heavier than those derived from the paraffin-base oils.

(2) REFINING OF PETROLEUM

In refiining petroleum the first step is to separate it by distillation into a series of cuts. In distillation, the compounds of low boiling point and light gravity pass over first and the heavier compounds pass over at a higher temperature. When the average gravity of the distillate reaches a certain fixed value, the distillation is cut over into another tank and another series of compounds are obtained of higher gravity, until the average gravity of this distillate reaches the next limit. In this way the crude oil is separated into the following cuts or fractions:

1. Benzine. All distillates of a gravity down to and including 53 deg. Baumé.
2. Burning oils. Those distillates of gravity between 52 deg. and 38 deg. inclusive.
3. Fuel oils. Distillates between 37 deg. and 25 deg. inclusive.
4. Residuum. The remainder of the petroleum either liquid or solid.

The gravity limits of the various fractions given above are more or less indefinite and vary among different manufacturers, but these divisions are the ones generally adopted. Those who have followed the development of the industry in the last few years have noted that the tendency has been toward gradually lowering these limits, particularly those of the benzine group.

After the first fractioning, as above, the benzine is put into a second or steam still and subjected to another distillation during which it is separated into gasolines and naphthas of gravity according to the demand of the trade, or the standards of the particular manufacturer. It will be seen from the method described above that any gasoline may embrace a number of compounds of different densities, and the hydrometer tells only the average density of the composition. A mixture of a certain gravity may be obtained either by straight distillation, as described above, or by blending very light distillates and heavy distillates in the proper proportions. While the gravity can be varied by proper blending, the boiling points of the components are unchangeable and by redistillation a blend can always be separated into its original components. In other words, an examination by redistillation makes it possible to accurately determine the composition of any gasoline or naphtha.

(3) UTILIZATION

In general, internal combustion engines utilize light distillates by means of an apparatus variously called a carburetor, vaporizor, or mixing valve. The action in this apparatus consists in breaking up the fuel into minute particles and thoroughly mixing it with air: for the best results the fuel should be so broken up as to be practically a vapor. The more volatile the fuel, the more easily it can be broken up and mixed with air. The nearer the boiling point of a compound is to its working temperature, the greater its volatility. Hence of any mixture the fractions of low boiling points are most easily volatilized and a knowledge of the boiling points of the various fractions are necessary to a knowledge of the behavior of the fuel as a whole. All of the fuel need not be of low boiling point. that is, easily vaporized; but there must be a sufficient percentage in order that starting will be assured. The remainder of the fuel must, however, be sufficiently volitile to be easily broken into a fog, or mist, and drawn into the cylinder without undue precipitation.

From the above consideration of practical conditions governing the burning of gasoline and naphtha, it can be seen that a knowledge of the boiling points is of much greater value in comparing relative suitability than knowledge of the gravity; and even if the gravity were desired, we can get only the average gravity of the entire mixture. It is, therefore, recommended that these light distillates be specified and purchased by the boiling point method. By this method the purchaser specifies the characteristics of the fuel as determined by a fractional distillation test. Such a test consists in placing a certain quantity of liquid in a flask, vaporizing it, condensing the vapor and catching it in a graduate. The percentages of the original volume obtained at the various temperatures may then be plotted on curves as shown in Fig. 1 and Fig. 2, which are characteristic curves of gasolines. If all conditions of petroleum composition and refining were the same the world over, gravity would then be a satisfactory means of comparison, for all curves would be of the same shape and parallel to each other as shown in Fig. 2, each curve representing a different gravity. Such, however, is not always the case, the true state of affairs frequently being as shown in Fig. 1. By the gravity method one would naturally expect a 72.5 deg. Baumé gasoline to give better results than one of 63.6 deg. Baumé, but in reality this particular 63.6 deg.

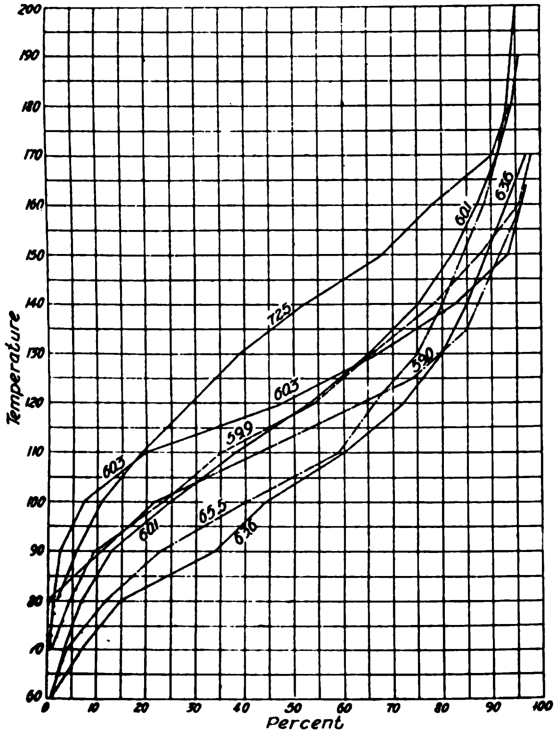

FIG. 1.

1439

Curves of fractional distillation of gasolines of various specific gravities and widely differing fuel values.

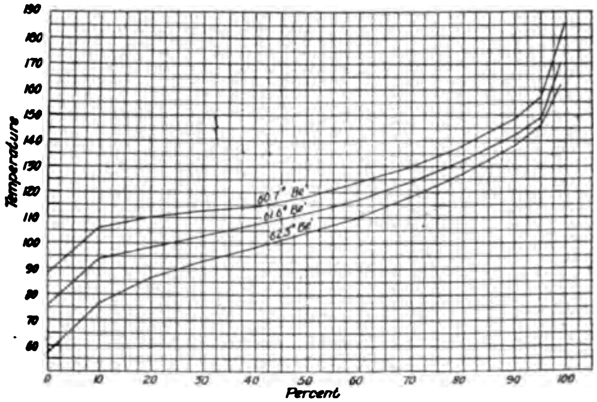

FIG. 2.

1440

Curves of fractional distillation of gasolines the values of which as a fuel are proportional to their hydrometer readings.

Baumé gasoline is much the better, as can be readily seen from the curves. This is contrary to the usual understanding and clearly indicates the fallacy of the gravity method of grading.

(4) SPECIFICATIONS AND PURCHASE

The problem of fuel for motor cars is amenable to the same solution as that of coal for steam boilers. By test the most suitable fuel must be determined, then the characteristics of this fuel definitely specified and competitive bids invited on fuel to meet the specifications.

The specifications based on fractional distillation should give initial boiling point, that is, the point at which the liquid starts to vaporize, the final boiling point at which all liquid has disappeared from the flask, and possibly two or three points in between, and the percentage of the quantity which should boil over at these temperatures. The initial boiling point should be the maximum temperature which will insure easy starting. Final boiling point should be set as high as possible so as to produce a fuel which will not burn too rapidly; in fact all points should be as high as practical, as high boiling points mean low prices. Fuel should, of course, be free from water and other impurities.

When the specifications of distillates are being prepared, it is well to consider the design of the engine and the purpose for which it is to be used. For instance, the ordinary automobile engine, usually of high piston speed, working under varying loads, needs a distillate having a narrow range of boiling points, that is, quick burning fuel. Heavy duty engines of slow piston speed and fairly constant loads operate better with fuels having the initial and final points a considerable distance apart, as the slow burning fuel develops a higher mean effective pressure. Automobile engines are also subject to another condition. Being required to start easily in cold weather, they must use a fuel having a larger percentage of components boiling at low temperatures than engines that are installed in buildings kept at a reasonable degree of warmth.

The following specification for liquid fuels will be found satisfactory for use on gas-electric cars.

a. Fuel shall be an unrefined petroleum distillate free from refuse, water, sand, etc.

b. The initial boiling point shall not be in excess of 185 deg. F. (85 deg. C.).

c. Dry point shall not be in excess of 550 deg. F. (228 deg. C.).

d. The first 10 per cent should distill at a temperature not in excess of 230 deg. F. (110 deg. C.).

e. Sixty per cent should distill at a temperature not exceeding 347 deg. F. (190 deg. C.).

f. Not less than 95 per cent of the liquid should be recovered from the distillation.

g. The above figures are based on the Engler process; if other methods of distillation are used results must be corrected to equivalent values.

For engines requiring quick acceleration and widely varying loads, a fuel having a narrow range of boiling point is desired. For these conditions the following specifications are recommended:

A. Fuel shall be free from impurities.

B. The initial boiling point shall not be in excess of 185 deg. F. (85 deg. C.).

C. Dry point shall not be in excess of 356 deg. F. (180 deg. C.). (Dry point will be indicated by a small puff of white vapor from residue in flask.)

D. The fractional distillation proceeding at the rate of one drop per second should be recorded in ten per cent cuts.

E. The first 10 per cent should distill at a temperature not in excess of 230 deg. F. (110 deg. C.).

F. Fifty per cent should distill at a temperature not exceeding 270 deg. F. (132 deg. C.).

G. Not less than 97½ per cent of the liquid should be recovered from the distillation.

Those who have been interested in the purchase of coal to specifications will immediately note that there is no mention, whatever, of heat value in the above specifications. The reason for this apparent omission is as follows:

All petroleum and petroleum products have practically the same heat value, i.e., 19,000 to 21,000 B.t.u. per pound, and as there is, at present, no suitable distillate commercially practical, the heat value of petroleum products can be safely assumed.

(5) POSSIBILITIES OF OTHER LIQUID FUELS

At the present time there is a widespread demand for a cheaper and more efficient fuel than the gasoline and naphtha discussed above. The demand seems to have been met by a type of internal combustion engine utilizing heavy oils, generally known as the Diesel or high-compression oil engine. Much has been claimed for this apparatus, and the claims have been well substantiated in stationary and marine service, but as yet no engine of this type has been developed that is available for motor car service.

Any article considering liquid fuels for internal combustion engines would be manifestly incomplete without a word in regard to alcohol and coal distillates, more generally known as benzol.

Generally speaking, alcohol, either wood, grain or denatured, is a fuel even better than gasoline, and undoubtedly will figure more prominently in the future than it has in the past. Its advantages lie in the fact that it can be obtained from any vegetable matter and is, therefore, available in nearly all parts of the world.

The apparatus required is simple, inexpensive, and the cost of production small. Chemically, alcohol is a much more simple substance than gasoline and will be found more uniform.

The only reason that prevents its use is the price, and perhaps certain government restrictions in regard to inspection, bonding, and storing. Constant search is being carried on for a vegetable which will yield large quantities of alcohol at minimum cost. In Cuba, sugar cane refuse will furnish alcohol that may be sold at 12 to 15 cents per gallon.

When the problem of production has been satisfactorily worked out, alcohol withe ven a lesser heat value than gasoline, that is, 14,000 B.t.u., will be a competitor on the fuel market.

In Europe there is a gasoline substitute called benzol which is meeting with considerable success. This fuel is produced by the destructive distillation of coal. In the matter of advantages and disadvantages it ranks between unrestricted alcohol and gasoline. Like alcohol, it is a simple mixture and uniform. Like gasoline, it has a high heat value ranging from

18,000 to 19,000 B.t.u. It is heavier than gasoline and, therefore, more work is obtained per gallon.

The price of benzol is against its use, however, for unless gasoline be over 25 cents a gallon, the cost of production of benzol from coal at $1.75 per ton, even with the revenue derived from the other products of distillation, will prohibit its use. It seems probable that with our enormous coal deposits there will be developed a means for producing benzol more economically.

LUBRICATION

The successful lubrication of internal combustion engines has in the past been considered a difficult proposition and one surrounded by more or less mystery, the difficulty being to obtain an oil that will work under the little known conditions that exist in the combustion chamber.

The prevailing idea of a gas engine oil was that it should have a high flash and fire test, supposedly in order to withstand the high temperature of the combustion chamber. The flash and fire test temperatures have usually been between 400 and 500 deg. F., but it is manifestly impossible to expect that an oil of this test will not burn in a temperature variously estimated to be between 1800 and 2500 deg. F. Whatever have been the troubles with internal combustion engine lubrication in the past, the problem is now satisfactorily solved and much is known as to the lubrication conditions of the cylinder, and oils for this purpose can be and are prepared which produce entirely successful results.

The idea of lubrication is the same with all pieces of apparatus, that is, to successfully lubricate at minimum expense. To lubricate is of prime importance. The matter of economy should be secondary. As the first feature must be obtained, we will therefore assume successful lubricating oils. To attain economy, we must have an oil of which little is used, or which wears well. Therefore, the aim should be to prevent excess oil getting to the combustion chamber, thereby using as little as possible, and second, to obtain a clean burning oil, that is, one which upon burning leaves as little carbon as possible.

The quantity of oil passing by the piston rings to the combustion chamber is governed by the viscosity of the oil and the construction of the engine and its lubricating system. A gravity feed inherently permits the quantity of oil consumed to be accurately controlled. As the storage for this oil is usually set away from the engine and kept at low temperatures, a much different oil is required than with either the force feed or splash lubrication system. As the storage for oil in the latter system is generally the lower portion of the crank case, all oil is speedily warmed to a rather high temperature, with a consequent loss of viscosity. As in different makes of engines there are differences in piston fit, number and size of rings, and heating of the oils, different viscosities are naturally needed for best results. The question of the most suitable viscosity is one to be settled by each manufacturer, although the personal equation of the operator has great bearing on the success to be obtained from the use of any oil.

A clean-burning oil must primarily be free from dirt and sediment, but aside from this there will be a certain amount of carbon deposit from the combustion. The amount of this deposit is usually determined by the carbon residue test, which consists in vaporizing and burning a certain amount of oil and measuring the percentage of carbon residue remaining after all liquid has disappeared. All carbon desposit is not, however, due to excess or poor quality of oil. Excess of fuel or dirty fuel may cause much more carbon than it is possible to obtain from the lubricating oil.

The importance of high-flash and fire tests have been greatly overestimated. However, the oil should test sufficiently high to prevent undue loss by vaporization from the hot wall of the cylinder and piston. Engines which are subject to cold weather use should have an oil of low cold test, otherwise when the engine is first started the oil may be so stiff as not to splash or flow, and the engine be without lubrication for a considerable period. In general, it may be said that any good gas engine oil from a reputable manufacturer can be used successfully, although, depending on the conditions of operation and construction of the engine, certain oils can be used with a greater degree of satisfaction than others.

Thus far no specifications or laboratory tests of oil have been found that are satisfactory for general use. The practical workout test is by far the best means of determining the merits of a lubricating oil. When purchasing an oil its first cost should not be given undue importance. The cost of motor car operations is figured on a car mile basis, and the life of an oil—that is to say, the number of car miles per gallon or the cost per car mile—must be regarded as the only final criterion of the value of an oil.

—*General Electric Review.*

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COAST DEFENSE IN FRANCE

From a *Letter from Paris* in *The Navy*, it is learned that the organization for coast defense under the Ministry of Marine, mentioned on page 344 of the JOURNAL for November-December, 1913 (Vol. 40, No. 3, whole No. 124), as planned for April, 1914, will be instituted gradually, a beginning being made on April 1st, when the coast defenses in the vicinity of the navy yards of the first class (Cherbourg, Brest, Toulon, and Bizerta) will be manned by naval gun crews recruited from the *inscrits maritimes*. A new corps called the "Coast Defense" is to be created, with a rear admiral at its head.

BOOK REVIEWS

Taschenbuch der Kriegsflotten, 1914. By B. Weyer, Kapitanleutnant a. D. Munchen, Germany: J. F. Lehmanns' Verlag. 5" x 6¾". 583 pp. Numerous sketches, silhouettes, and plans of ships. Cloth. Price, M5.

The Handbook of Navies, by Weyer, has recently made its appearance. A cursory glance at the contents will show that while the general arrangement of the previous issue has not been altered, nevertheless the present issue is thoroughly revised and improved upon in many respects.

Part I, pp. 6-409, gives, in the list of navies of all nations, exact and reliable data relative to the offensive and defensive means at the disposal of each ship, its guns, torpedoes, armor, speed, and crew, as well as data concerning its length, beam, depth, radius of action, coal and oil carrying capacity, and kind of engines and power. The dates of authorization, building, and completion of the ships are also given. This detailed information is of especial interest in the case of the latest ships of the line and armored cruisers, showing how considerably these have advanced in size and power in all navies. The conscientious endeavor of the author to present only such data as are actually authentic, and to omit what appears doubtful, is evident.

It is of interest to note that the German ships of the line allowed by the budget of 1913 will have armament similar in number and caliber to that of the English ships provided for in 1912; viz., eight 38-cm. and sixteen 15-cm. guns. Comparison of armament is conveniently shown in the artillery plans of the frontispiece, as well as in the illustrated portion of the book, which, comprising photographic views and plans of all the latest ships, supplements the naval lists and enables one to see readily the arrangement and number of guns, as well as the distribution and thickness of armor.

Part II, pp. 410-441, gives a comparative review of the strength of the different navies by statistical and graphical grouping of all the latest ships of the line and armored cruisers, presenting separately the so-called dreadnoughts and battle-cruisers, which are characterized principally by an increased number of guns and greater speed. The graphical presentation is particularly instructive in the comparison it affords with former years, showing the development of the different navies—a comparative development which the German eye loves to contemplate. Then follow comparative tables of the chief fighting factors and gun plans of the latest dreadnoughts of all navies; strength of personnel; naval budgets and expenses for national defense during the past ten years; and a list of naval stations occupied, together with the naval formations of all sea powers.

Part III, pp. 442-493, contains data relative to the naval artillery of the fleets. Here are found the latest artillery tables (ballistic) of the large gun industries in Germany and abroad.

Part IV, pp. 494-517, is devoted to the Naval Policies, Naval Plans, and Activity in Naval Construction of the great powers. Under the heading "Germany" and "England" the author comments on the speeches made by the First Lord of the British Admiralty, Winston Churchill. The propositions contained therein are considered phantastic and detrimental to Germany, and hence unacceptable. The unprecedented powerful British naval preparations are pointed out, and recommendation is made that Germany continue with her naval program, on the principle that she is building what she considers necessary, regardless of what England may do.

Part V, pp. 518-550, contains an article, "Naval Interests," compiled by Prof. Harms, wherein all political factors are set forth with masterful brevity and clearness. Particularly interesting and valuable (from the German viewpoint) is that portion devoted to German naval interests in reference to and comparison with those of the great powers with which the German Empire is in continued and friendly emulation.

Part VI, pp. 550-564, includes the table of flags (German), conversion tables of weights, measures, etc.

Among the additional features noticed in the present issue is the list of navy yards of the different countries; list of names of steel works for guns and armor plate of the different naval powers; and data relative to the total weight of metal comprised in a broadside, included in the illustrated portion of the deck plans of the armored cruisers. The author desires it to be distinctly understood, however, that these data do not furnish a standard of comparison for gun efficiency of the ships, especially those of different nations. Other factors enter into consideration here, such as installation and grouping of the guns; their height; sector of fire; range; rapidity of fire; life; as well as their accuracy and the penetration and bursting effect of their projectiles at the different battle ranges.

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The Technique of Modern Tactics. By Majors P. S. Bond and M. J. McDonough, Corps of Engineers, U. S. Army. 6½" x 9¼". 314 pp. 16 il. Cloth. For sale by U. S. Cavalry Association, Fort Leavenworth, Kansas, and U. S. Infantry Association, Washington, D. C. Price, $2.65 postpaid.

This is a study of troop leading methods in the operations of detachments of all arms of the service. It is intended as a guide for the preparation and solution of practical problems in tactics for the use of students and instructors, and, as such, fills a long felt want. There is more genuine instruction in devising a good tactical problem than in solving well a good problem devised by some other person.

General Von Verdy simplified the war game by substituting the judgment of the umpire for the cumbrous paraphernalia which was formerly used to decide tactical situations. In his opinion, any well instructed officer could give a more satisfactory solution to such a situation than could be obtained by any mechanical means. It may be stated that it is the purpose of this book to give in compact form the instruction involving considerations of time, space, and fire effect necessary to the officer who would be fully equipped as a "well instructed officer." The authors discuss the preparation and solution of tactical problems, field orders, marches, camps and bivouacs, the tactics of the three arms, outposts, attack and defense, the problems of sanitation and supply, and the use of the rifle in war. The information on these various topics is logically and clearly arranged and the discussions are full and complete. Without being dogmatic, the authors are explicit and specific as to what may and may not be done to increase the probabilities of success. Discussions of principles are followed by map or maneuver problems of the type used at the Service Schools.

This book will be very useful to the coast artillery officer, for it contains much valuable information that has a direct bearing upon the preparation of plans and orders for the land defense of coast fortifications. It will also be of use to him in a larger sense. About ninety-seven per cent of the actions in which our coast companies have taken part have been field actions as distinguished from coast defense actions. The importance to coast artillerymen, therefore, of studies in tactics should be emphasized from time to time, lest they forget.

The *Technique of Modern Tactics* has the merit of being a readable book devoted to a serious and important subject. But it was not made for mere skimming. It will repay careful study on the part of all officers of all grades and of every age in the various arms of the service.

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Chemistry. Inorganic and Organic. With Experiments. Tenth Edition rewritten and revised by A. G. Bloxam, F.I.C., and S. J. Lewis, D. Sc., F.I.C. Philadelphia, Penn.: P. Blakiston's Son & Co., 1012 Walnut Street. 7" x 10". 878 pp. 313 il. 1913. Cloth. Price $5.00 net.

In the first edition of Bloxam's Chemistry, brought out in 1867, the principal aim of the author was to provide for the general student and the professional chemist as complete a survey of the science of chemistry as could be encompassed in a single volume. The accomplishment of this aim was made possible by the logical and careful arrangement of the matter and by the clear and concise style of the author. An important feature was the large number of well illustrated experiments given to bring out clearly the principles and theories set forth, and so well were these chosen that many still serve the purpose for which they were originally selected. The popularity of the method of treatment and the convenience of the one-volume feature soon gave the work an assured place among the standard scientific reference books.

The rapid and enormous development of chemistry since the sixties has made necessary the preparation of new editions from time to time; but, although the temptation to subdivide the book into two or more volumes must have been more difficult to resist as the mass of available knowledge has increased, the original idea has been adhered to, the absolute necessity for more space being met by the addition of pages, the enlargement of the pages, and the use of small type for the less important matter.

The tenth edition is not merely the ninth edition with a few new pages inserted here and there, but shows evidences of a careful rearrangement of the entire book and a rewriting of a considerable portion. Space for new matter has been obtained by increasing the size from 5½" x 8¾" to 6" x 9½", thus obviating the necessaity for adding more pages.

The most important change in the tenth edition is the introduction of the elementary principles of physical chemistry in the first part of the book, a change made necessary by the importance assumed by this branch since the preparation of the previous edition. After the introduction, water is first taken up, the description including both chemical and physical properties. Next follows a chapter on air in which the physical properties of gases are also considered. The third chapter is devoted to a general consideration of acids, bases, and salts, after which follow chapters on hydrogen and the non-metals.

At this point an important chapter on general principles and physical chemistry is introduced in which the essential principles of such subjects as the kinetic theory of gases, thermochemistry, valency, and radioactivity are clearly presented. These principles are further illustrated in the chapters on metals, which constitute the remainder of the first part of the book. The grouping of both metals and non-metals is in close accordance with the periodic classification, to which particular attention is given throughout the inorganic section of the work.

The last part of the book is devoted to organic chemistry, and in this part the familiar custom of treating separately the aliphatic and aromatic compounds is not followed. Both classes of compounds are considered together; though the usual division into hydrocarbons, alcohols, aldehydes, acids, etc., is made.

An excellent index and table of contents combine to make the contents readily accessible, a considerable improvement being made in this edition through the substitution of page numbers for paragraph numbers in the table of contents.

The editors of the tenth edition are to be congratulated on the production of a thoroughly up-to-date and comprehensive summary of chemistry under one cover. The accumulation of such a vast amount of useful and interesting data in one book indicates careful work and long experience, together with a wide knowledge of the subject. To those who desire in compact form practically all the information on the subject of chemistry ordinarily required or who desire to take up the study of this science in a logical sequence, the tenth edition is heartily recommended. To the professional chemist its value as a quick and ready reference is already well known and needs no mention here. It is sufficient to say that in this edition the encyclopaedic character of the work has been maintained and even enhanced, despite the ever increasing field to be covered, and that the qualities of clearness, completeness, and reliability are present in the same high degree as in previous editions.

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Cinquante Annees de Canon Raye. By Commandant Morelle. Paris: Libraire Militaire Berger-Levrault. 5-7 Rue des Beaux-Arts. 5½" x 8¾". 44 pp. Paper. Price, 1 fr. 50.

This brochure includes a history of the development of the French field gun and its immediate accessories, from the earliest use of the rifled bore, and the parallel development of regulations for fire control and direction and certain accepted tactical principles, together with a discussion of the questions of the proportion of guns to infantry, and the addition of light howitzers to the field matériel.

All four subjects are treated in the briefest possible manner, as the pamphlet is intended rather for popular instruction than for technical study, aiming at a more intelligent general appreciation of the progress, present efficiency, and needs of the field artillery by the French "man in the street."

The matter has no direct bearing on the problems of the coast artilleryman of our service, but should be interesting to every field artilleryman from a strictly professional point of view; while the beautiful lucidity and directness of the style make the brochure valuable as practice reading for any student of military-technical French.

It may properly be noted, in connection with this review, that it is unfortunate that similar pamphlets pertaining to the needs and efficiency of the various arms of our own service are practically unobtainable: something of the kind is desirable to remove the popular unfamiliarity with us and our needs that blocks our every attempt to improve or advance.

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Bausteine zur Flugbahn-und Kreisel-Theorie. By August Dahne, Koniglich Preussischer Major a.D. Berlin: Verlag von R. Eisenschmidt, Dorotheenstr. 60. 6½" x 9½". 44 pp. 5 il. Paper. 1914. Price, M 1.50.

In his preface, the author states his purpose of investigating the factors which determine the form of the trajectory, and to this end he approaches his subject from two points of view. In the first part of his work, the author discusses the "Theory of Rotation of Bodies," in which he treats of the mechanical features of gyroscopic motion; and in the second part, he applies his theory deduced in the former to the "Motion of the Projectile" in its trajectory. The influence of the length of the projectile and of the position of the center of gravity in the projectile on the drift, is given at some length and with illustrations from actual firings. The author advances the interesting theory that increased range from a certain gun was due, not alone to the more favorable shape of head, but principally to a change in the position of the center of gravity of the projectile which brought the center of gravity nearer the base of the projectile.

Major Dahne seems to have been a pioneer in investigating this subject, having published his first work on this phase of exterior ballistics as early as 1884.

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Pistola Automatica, Sistema "Campo-Giro." By Lt. Col. D. Venancio Lopez de Ceballos y Aguirre, General Staff, Retired. Madrid: Imprenta de Eduardo Arias, San Lorenzo, num. 5. 9½" x 6¼". 1914.

This is a pamphlet of 32 pages and 2 plates, describing the "Campo-Giro" automatic pistol adopted for use for the Spanish army by royal order of the fifth of January, 1914.

The general features of this automatic pistol and a comparison with other makes are first given, followed by a list of the parts of the pistol and a description of the several parts, pp. 1-19; pp. 19-22 are devoted to a detailed description of the operation of the pistol, pp. 22-25 to instructions for dismounting the pistol, and pp. 25-27 to assembling the same. Certain descriptive data relating to the caliber, weight, dimensions, and ballistics of the pistol, follow. The last four pages are devoted to calculations relating to the recoil of the arm, its muzzle energy, pressure on the breech plug, and safety.

This pistol is of 9 mm. caliber, has a muzzle velocity of 355 meter-seconds, muzzle energy of 53.3 kilogram-meters, penetration in pine at 25 meters of 150 mm., and weighs 950 grams. The magazine holds seven cartridges, with one in the chamber. It replaces the automatic pistol by the same designer (the author of this pamphlet) adopted in 1912. It differs from the earlier model principally in that it is provided with effective means for reducing the shock of recoil so that the pistol can be successfully handled in large calibers of high power.

The plates are quite good and the descriptive matter complete. It should be a valuable pamphlet to anyone interested in automatic pistols.

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The V. C. Its Heroes and Their Valour. By D. H. Parry. New York: Funk and Wagnalls Co., 354 Fourth Avenue. 6" x 8". 520 pp. 8 il. 1913. Price, $1.75 net; by mail, $1.90.

This book gives an interesting series of thrilling accounts of the acts in which the Victoria Cross has been won in the various wars and campaigns from the Crimea in 1854-6 to Thibet in 1903-4. The Duke of Newcastle, Secretary of State for War, 1854-5, is credited with having originated the idea of the Cross, desiring to institute an order which might be open to all ranks, like the French Legion of Honor.

The Victoria Cross has been given to 522 persons, 26 of whom have been in the medical branch of the service and 21 in the Royal Navy. A very large proportion of the crosses have been won in attempting to succor the wounded under dangerous circumstances, and in taking risks when the display of sublime heroism at critical periods between defeat and victory has given heart to all who were witnesses of the acts.

While authority for the accounts varies between tradition and official records, the book presents, in many examples, a beautiful picture of the willingness of Great Britain's soldiers, from humble private to exalted officer, to sacrifice themselves for each other or their common cause; it portrays the stubborn courage and devotion to duty which has characterised Great Britain's soldiers in many lands.

✤ ✤ ✤

General War Plans of the Ordnance Department, U. S. Army. Washington, D. C.: War Department. 5" x 7¼". Paper. 1913. Mobilization Drawings, 8¼" x 14¼" (leather), 6 plates.

The year 1913 marks an epoch in the preparation of the United States for war, the completion of the "General War Plans of the Ordnance Department" in that year entitling it to such distinction.

It is difficult in a review to do justice to the value of the achievement or to give an idea of the labor involved: no new principles are discovered, nor is there presented a wordy treatise of old; but through wonderful care in provision for the infinitude of detail that is wont to overwhelm an ordnance service upon the outbreak of hostilities, a really great work has been accomplished.

Whether the particular plans formulated for the accomplishment of an object are the best possible, if a question at all, pales into comparative insignificance when, as here, the plans are worked out with such thoroughness in provision for every detail as to ensure success.

The study the Ordnance Department set itself in preparing the plans, to determine the things necessary to be done in the event of war; to make all preliminary arrangements as far as possible in time of peace; and to provide for the execution of the remaining steps, in proper sequence, upon declaration of war. How well the study has been executed can best be indicated by reference to the drawings and tables in which the means of distribution are represented.

The first drawing shows the peace strength of the regular army and the organized militia, and the recruits necessary for raising the organizations of both to field strength, as well as the number of volunteers to be raised. For the purpose of providing small arms and personal and horse equipments, the increase in regulars and militia and the total number of volunteers are indicated according to arm of service and distributed among five ordnance supply sections, which are represented as to boundries and supply arsenals on an outline map of the United States. With the exception of Ordnance Supply Sections Nos. 1 and 2, which are both included in the Eastern Department, each supply section is coincident with a military department of the continental United States.

The second, third, and fourth drawings are detailed drawings subsidiary to the first, one relating to recruits for the regular army, one to recruits for the organized militia, and one to the volunteers that are to be raised.

The second drawing includes an outline map of the continential United States, on which are indicated the numbers of recruits of the several arms of the regular service to be armed and equipped at each of the five recruit depots, and the arsenals from which the recruit depots are to draw their supplies.

The third drawing presents an outline map of the continental United States on which are shown the state mobilization camps and the numbers of recruits required to raise the organized militia of each state to war strength, as well as the boundaries and supply arsenals of the several ordnance supply sections.

The fourth drawing presents an outline map of the continental United States on which are indicated the boundaries and supply arsenals of the five ordnance supply sections, together with the numbers of volunteers of each arm of the service for the equipment of which each supply arsenal is to be responsible.

The fifth and sixth drawings relate to the Ordnance Depots for Divisions in the Field.

Besides the subjects of distribution of supplies and maintenance in the field, to which alone brief reference has thus far been made in this review, the Plans include provision for procurement of supplies and for the details of administration. These latter have been so far worked out in time of peace as to include letters to the Secretary of War recommending legislation to permit ordnance supplies to be purchased without advertisement and abroad, and include estimates for additional funds for war purposes.

The "War Plans of the Ordnance Department" are gaining general recognition as epoch making. In an essay on *Organization* by Naval Constructor G. S. Radford, published in the *Proceedings of the U. S. Naval Institute*, they are cited "as an excellent example of the application of the general staff method to the work of providing war material," and are characterized as "one of the finest pieces of constructive work for the national defense that has been executed in many years." Naval Constructor Radford states them to be the work of Colonel John T. Thompson, under the direction of Brigadier-General William Crozier, Chief of Ordnance.

A Reader of Scientific and Technical Spanish for Colleges and Technological Schools with Vocabulary and Notes. By Lieut.-Col. Cornelis De Witt Willcox, Professor, U. S. Military Academy. New York: Sturgis and Walton Co., 31 East 27th St. 5" x 7½". 588 pp. 67 il. Cloth. 1913. Price, $1.75 net.

This book is composed of a well chosen collection of articles by Spanish authors of repute, taken from text books, technical journals, and reports, covering very broadly the field of industrial engineering in addition to elementary physics, chemistry, electricity, water power, steam, etc., with a due attention to the military phase of certain branches, all supplemented by a technical vocabulary. All of the matter on industrial engineering and its contributory elements is thoroughly modern, and is of value to the student as well for the facts and principles presented as for the technical terminology which is offered. Of the more particularly military matter, which includes articles on Modern Powders, Military Railways, Submarines, the Campaign of Santiago, and a short Description of Mexico, that on Military Railways is of date 1885, and is of value for but little more than vocabulary, the rest, however, being entirely up to date. The Description of Mexico has at this time a most lively interest for all officers.

Of the 588 pages about 420 are devoted to industrial subjects, 63 to the vocabulary, and only about 110 to subjects having any peculiarly military application, so that it may be concluded that it is intended for use by engineering rather than military students, or, more accurately, for the engineering side of a military student's training rather than for his peculiarly military training. The brief list of military subjects is a further evidence to this point.

Some of the engineering articles are those on Power Transmission, Mining, Bridges, Surveying, Topography, The Automobile, and Aeronautics.

The vocabulary is attractively arranged for easy and rapid use, along the lines with which many officers are familiar in the French-English Military-Technical Dictionary by the same author.

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Index to Current Military Literature

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PUBLISHED WITH THE

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1914

KEY

TO

INDEX TO CURRENT MILITARY LITERATURE

The periodicals cited are arranged by government, and each periodical is assigned a symbol consisting of an initial, or other abbreviation of the governmental designation, and a numeral indicative of the periodical's position in an alphabetical arrangement of the Journal of the United States Artillery's exchanges under that government.

Prices of subscription are given in the currencies of the countries of publication.

All the periodicals cited are preserved in the Library of the Coast Artillery School at Fort Monroe, Virginia.

ARGENTINE

Ar-0.5	*Anuario del Instituto Geografico Militar de la Republica Argentina* 3ª Division del Estado Mayor del Ejército Buenos Aires	Annual
Ar-1	*Boletin del Centro Naval* Florida 659, Buenos Aires	Bimonthly Per year $\$^{m}/_{n}11.90$
Ar-1.5	*Revista del Circulo Militar* 255 Maipu Buenos Aires	Monthly Per year $\$12.00$
Ar-2	*Revista Militar* Ministerio de Guerra, Santa Fe 1161 Buenos Aires	Monthly Per year $\$^{m}/_{n}9.00$

AUSTRIA

Au-1	*Mitteilungen aus dem Gebiete des Seewesens* Pola	Monthly Per year 17 M
Au-2	*Mitteilungen ueber Gegenstaende des Artillerie-und Genie-Wesens* Getreidemarkt 9 Wien, VI.	Monthly Per year 20 M
Au-3	*Streffleurs Militaerische Zeitschrift zugleich Organ der militaerwissenschaftlichen Vereine* I. Graben, 13. Wien	Monthly Per year 28 M
Au-4	*Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines* I. Eschenbachgasse, No. 9 Wien	Weekly Per year 34 K

BELGIUM

Be-1	*Belgique Militaire, La* Rue Albert de Latour 50 Schaerbeek, Brussels	Weekly Per year 12 fr 50

Be–2	*Revue de l'Armée Belge* 24 Rue des Guillemins, Liege	Bimonthly Per year 13 fr
Be–3	*Revue de l'Ingénieur et Index Technique* 70, Boulevard d'Anderlecht, Brussels	Quarterly Per year 30 fr

BRAZIL

Br–1	*Boletim Mensal do Estado Maior do Exercito* Ministerio de Guerra Rio de Janeiro	Monthly
Br–2	*O Tiro* Rio de Janeiro	Monthly
Br–3	*Revista Maritima Brazileira* Rua D. Manoel n. 15 Rio de Janeiro	Monthly Per year 12$000

CHILE

C–1	*Memorial del Estado Mayor del Ejercito de Chile* Talleres del Estado Mayor-General Santiago	Monthly
C–2	*Revista de Marina* Casilla del Correo 976, Valparaiso	Monthly Per year $15.00

COLOMBIA

Co–1	*Memorial del Estado Mayor del Ejercito de Colombia* Jefe del Departamento de Historia del Estado Mayor-General Bogota	Bimonthly Per year $0 50 oro

DENMARK

D–0.5	*Dansk Artilleri-Tidsskrift* Copenhagen	Bimonthly Per year 5 kr
D–1	*Militært Tidsskrift* Copenhagen	Semimonthly Per year 8 kr

DOMINICAN REPUBLIC

DR–1	*El Porvenir Militar* Salome Urena No. 8 Santo Domingo	Monthly

ECUADOR

E–1	*Boletin del Estado Mayor General* Quito	Monthly Per year $4.00

FRANCE

F–1	*Archives Militaires, Les* Librairie Militaire Berger-Levrault 5-7 Rue des Beaux-Arts, Paris	Quarterly Per year 14 fr
F–2	*France Militaire, La* 10 Rue Danton, Paris	Daily Per year 32 fr
F–3	*Génie Civil, Le* 6 Rue de la Chausée d'Antin, Paris	Weekly Per year 45 fr
F–4	*Journal des Sciences Militaires* 30 Rue et Passage Dauphine (VI^e) Paris	Semimonthly Per year 40 fr

F-5	*Liste Navale Francaise*	Quarterly
	Quai Cronstadt, au coin de la Rue Neuve	Per year 9 fr
	Toulon	
F-6	*Memoires et Travaux de la Société des Ingénieurs Civils*	
	19 Rue Blanche	Monthly
	Paris	Per year 36 fr
F-7	*Memorial des Poudres et Salpetres*	Semiannually
	55 Quai des Grands-Augustins, Paris	Per year 13 fr
F-8	*Mois Scientifique et Industriel, Le*	Monthly
	8, Rue Nouvelle, Paris	Per year 25 fr
F-9	*Monde Militaire, Le*	Fortnightly
	6 Rue de la Chaise, Paris	Per year 6 fr
F-10	*Revue d'Artillerie*	Monthly
	5 Rue des Beaux-Arts, Paris	Per year 22 fr
F-11	*Revue de Cavalerie*	Monthly, ex. Aug
	5 Rue des Beaux-Arts, Paris	Per year 27 fr
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F-13	*Revue d'Infanterie, La*	Monthly
	10 Rue Danton, Paris	Per year 25 fr
F-14	*Revue Maritime*	Monthly
	30 Rue et Passage Dauphine, Paris	Per year 36 fr
F-15	*Revue Militaire des Armées Etrangères*	Monthly
	Librairie Chapelot	Per year 15 fr
	30 Rue et Passage Dauphine, Paris	
F-16	*Yacht, Le, Journal de la Marine*	Weekly
	55 Rue Chateaudun, Paris	Per year 32 fr

GERMANY

G-1	*Artilleristische Monatshefte*	Monthly
	Bernburgerstr. 24-25 Berlin, S. W. 11	Per year 27 M
G-2	*Eisen-Zeitung*	Weekly
	Verlag von Otto Elsner, Berlin, S. 42	Per year 12 M
G-3	*Ingenieur, Der*	Semimonthly
	Verlag Buchdruckerei P. Posekel,	Per year 16 M
	Gneisenaustrasse 67, Berlin S. 61,	
G-3.5	*Kriegstechnische Zeitschrift*	10 Nos. per yr.
	E. S. Mittler & Sohn	Per pear 10 M.
	Königliche Hofbuchhandlung,	
	Kochstrasse, 68-71, Berlin, S. W.	
G-4	*Marine Rundschau*	Monthly
	Koch Strasse, 68-71, Berlin, S.W.	Per year 10 M
G-5	*Militaer Wochenblatt*	3 times a week
	With monthly Supplement	Per year 18 M
	Koch Strasse, 68, Berlin, S.W., 12	
G-6	*Schiffbau*	Semimonthly
	Zimmerstr. 9, Berlin, S.W., 68	Per year 20 M
G-8	*Ueberall*	Monthly
	Verlag: Boll und Pickardt	Per year 15.6 M
	Berlin, N.W. 7	

G-9	*Zeitschrift für das Gesamte Schiess- und Sprengstoffwesen* J. F. Lehmann's Verlag, Paul Heysestrasse 26, Munich.	Semimonthly Per year 26 M

HOLLAND

H 1	*Orgaan der Vereeniging ter beoefening van de Krijgswetenschap* Z. O. Buitensingel 221 The Hague	Six Nos. per yr. Per year 4 florins
H 2	*Wetenschappelijk Jaarbericht. Vereeniging ter beoefening van der Krijgswetenschap* Z. O. Buitensingel 221 The Hague	Yearly Per year 2 florins

ITALY

I 1	*Lista Navale Italiana* Officina Poligrafica Italiana, Rome	Quarterly Per year 15 L
I-2	*Rendiconti delle Esperienze e Degli Studi Eseguiti Nello Stabilimento di Esperienze e Costruzioni Aeronautiche del Genio* Viale Giulio Cesare N. 2, Rome	Occasional Per year 13.50 L
I-3	*Rivista di Artiglieria e Genio* Tipografia Enrico Voghera Via Astalli 15, Rome	Monthly, ex. July Per year 20 L
I-4	*Rivista Marittima* Officina Poligrafica Italiana Rome	Monthly Per year 25 L

MEXICO

M-1	*Boletin de Ingenieros* War Dept., Mexico City	Monthly
M-2	*Revista del Ejercito y Marina* Departamento de Estado Mayor City of Mexico	Monthly

NORWAY

N 1	*Norsk Artilleri-Tidsskrift* Christiania	Bimonthly Per year 6 kr
N-2	*Norsk Militært Tidsskrift* Christiania	Monthly Per year 8 kr

PERU

Pe 1	*Boletin del Ministerio de Guerra y Marina* Apartado de Correo No. 91, Lima	Fortnightly

PORTUGAL

Po-1	*Anais do Club Militar Naval* 43 Rua do Carmo, Lisbon	Monthly Per year 4$200
Po-2	*Revista de Artilharia* Rua do Carmo, 43, 2°., Direito, Lisbon	Monthly Per year 3$000 rs
Po-4	*Revista Militar* Largo da Annunciada, 9, Lisbon	Monthly Per year 3$000 rs

RUSSIA

R-1	*Imperial Nicholai War Academy Recorder, The*	Monthly
	St. Petersburg	Per year 6 rubles
R-2	*News of the Officers' Artillery School*	Monthly
	Zarskoe Selo	Per year 10 rubles

SPAIN

Sp-1	*Informacion Militar del Extranjero*	Monthly
	Madrid	
Sp-2	*Memorial de Artilleria*	Monthly
	Museo de Artilleria, Madrid	Per year 18 ps
Sp-3	*Revista Cientifico-Militar*	Semimonthly
	Paseo de San Juan, 201, Barcelona	Per year 40 ps
Sp-4	*Revista General de Marina*	Monthly
	Ministerio de Marina, Madrid	Per year 25 ps

SWEDEN

Sn-1	*Artilleri-Tidsskrift*	Bimonthly
	Artillerigarden, Stockholm	Per year 6 kr

SWITZERLAND

Sd-1	*Allgemeine Schweizerische Militaer-Zeitung*	Weekly
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	Avenue Juste Olivier, Lausanne	Per year 15 fr
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	Frauenfeld	Monthly
		Per year 5 fr
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	Frauenfeld	Monthly
		Per year 8 fr

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UK-3	*Army Review, The*	Quarterly
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UK-4	*Canadian Military Gazette*	Semimonthly
	Room 16, Trust Bldg.	Per year $2.50
	Ottawa, Canada	
UK-5	*Commonwealth Military Journal, The*	Quarterly
	Melbourne, Australia	
UK-6	*Electrician, The*	Weekly
	1, 2 and 3, Salisbury Court, Fleet Street	Per year 30s
	London	

UK-7	*Electrical Review* 4, Ludgate Hill, London, E. C.	Weekly Per year £1 10s
UK-8	*Engineer, The* 33 Norfolk Street, Strand London, W.C.	Weekly Per year £1 16s
UK-9	*Engineering* 35-36 Bedford Street, Strand London, W.C.	Weekly Per year £1 16s
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UK-13	*Journal of the Royal United Service Institution* Whitehall, London, S.W.	Monthly Per year 24s
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UK-23	*Transactions of the Canadian Society of Civil Engineers* 176 Mansfield Street Montreal, Canada	
UK-24	*Transactions of the Institution of Naval Architects* 5 Adelphi Terrace, London, W. C.	
UK-25	*United Service Gazette* Caxton House, 11 Gough Square, Fleet Street, London, E. C.	Weekly Per year £1 10s 6d
UK-26	*United Service Magazine* 31, Haymarket London, S. W.	Monthly Per year £1 1s

UNITED STATES

US-1	*Aeronautics* 250 West 51th Street, New York City	Semimonthly Per year $3.00

US-2L	*American Historical Review, The* The Macmillan Company 41 N. Queen Street, Lancaster, Pa., or 66 Fifth Avenue, New York City	Quarterly Per year $4.00
US-3L	*American Journal of International Law, The* Baker, Voorhis & Co., 45 John St., N.Y.	Quarterly Per year $5.00
US-4	*American Journal of Mathematics* Johns Hopkins Press Baltimore, Md.	Quarterly Per year $5.00
US-5	*Arms and The Man* 1502 H Street, N.W., Washington, D. C.	Weekly Per year $3.00
US-6	*Army and Navy Journal* 20 Vesey Street, New York	Weekly Per year $6.00
US-7	*Army and Navy Register* Washington, D. C.	Weekly Per year $3.00
US-8	*Bulletin of the American Geographical Society* Broadway at 156th Street, New York City	Monthly Per year $5.00
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US-14	*Bulletin of the University of Illinois* Urbana, Illinois	
US-15	*Bulletins, Circulars and Technical Papers* *Bureau of Mines* Department of the Interior Washington, D. C.	Occasional Free
US-16L	*Canal Record* Ancon, Canal Zone, Isthmus of Panama	Weekly Per copy 5c
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US-17.75 L	*Colonial Wars* 9 Ashburton Place Boston	Quarterly Per year $3.00
US-18	*Compressed Air Magazine* Compressed Air Magazine Co. Easton, Pa.	Monthly Per year $1.50
US-19	*Confederate Veteran* Nashville, Tenn.	Monthly Per year $1.00
US-20	*Craftsman, The* 41 W. 34th Street, New York	Monthly Per year $3.00
US-21	*Electric Journal, The* 200 Ninth Street, Pittsburgh, Pa.	Monthly Per year $1.50
US-21.5	*Electrical Engineering* Dalton, Georgia	Monthly Per year $1.00

US-22	*Electrical Review and Western Electrician* Heisen Building 608 South Dearborn Street, Chicago	Weekly Per year $3.00
US-24	*Engineering Magazine, The* 140-142 Nassau Street, New York	Monthly Per year $3.00
US-25	*Engineering News* 505 Pearl Street, New York	Weekly Per year $5.00
US-27	*Field Artillery Journal, The* U. S. Field Artillery Association 1701 Pennsylvania Avenue, N.W. Washington, D.C.	Quarterly Per year $4.00
US-28	*Flying and The Aero Club of America Bulletin* 297 Madison Ave., New York	Monthly Per year $3.00
US-29	*General Electric Review* General Electric Company Schenectady, New York	Monthly Per year $2.00
US-30	*Infantry Journal* U. S. Infantry Association 814 Seventeenth Street, N.W Washington, D. C.	Bimonthly Per year $3.00
US-31L	*Journal of American History, The* 3 West 43rd Street, New York	Quarterly Per year $3.00
US-31.5	*Journal of Efficiency Society, Inc.* 29 West 39th Street, New York City	Monthly Per year $3.00
US-32	*Journal of Industrial and Engineering Chemistry, The* The American Chemical Society, Easton, Pa.	Monthly Per year $6.00
US-33	*Journal of The American Society of Mechanical Engineers, The* 29 West 39th Street, New York City	Monthly Per year $3.00
US-34	*Journal of the American Society of Naval Engineers* Navy Department, Washington, D.C.	Quarterly Per year $5.00
US-35	*Journal of the Association of Engineering Societies* 3817 Olive Street, St. Louis, Mo.	Monthly Per year $3.00
US-36	*Journal of the Franklin Institute* 15 South Seventh Street, Philadelphia, Pa.	Monthly Per year $5.00
US-37	*Journal of the Military Service Institution* Governor's Island, New York	Bimonthly Per year $3.00
US-38	*Journal of the U. S. Artillery* Fort Monroe, Virginia	Bimonthly Per year $2.50
US-39	*Journal of the U. S. Cavalry Association* Fort Leavenworth, Kansas	Bimonthly Per year $2.50
US-40	*Journal of the Western Society of Engineers* 1735 Monadnock Block Chicago, Illinois	Monthly ex. July and Aug Per year $3.00
US-41	*Machinery* 49-55 Lafayette Street, New York	Monthly Per year $2.50
US-42	*Metal Industry, The* 99 John Street, New York	Monthly Per year $1.00

US-43	*Military Surgeon, The* 535 North Dearborn Street Chicago, Illinois	Monthly Per year $3.50
US-45L	*National Geographic Magazine, The* Hubbard Memorial Hall Washington, D. C.	Monthly Per year $2.50
US-46	*National Guard Magazine, The* 136-140 East Gay Street Columbus, Ohio	Monthly Per year $1.00
US-47	*Navy, The* Southern Building Washington, D. C.	Monthly Per year $2.00
US-47.5L	*North American Review, The* The North American Review Publishing Company New York City	Monthly Per year $1.00
US-48	*Official Gazette of the United States Patent Office, The* Supt. of Documents, Gov. Printing Office Washington, D. C.	Weekly Per year $5.0
US-49	*Pennsylvania Magazine of History and Biography* Philadelphia, Pa.	Quarterly Per year $3.00
US-50	*Physical Review* 41 North Queen Street, Lancaster, Pa.	Monthly Per year $6.00
US-51	*Polytechnic, The* Troy, N. Y.	10 Nos. per yr. Per year $2.00
US-52	*Popular Mechanics* 6 N. Michigan Boulevard, Chicago, Ill.	Monthly Per year $1.50
US-53	*Practical Electricity and Engineering* 608 South Dearborn Street, Chicago, Ill.	Monthly Per year $1.00
US-54L	*Proceedings of the American Institute of Electrical Engineers* 33 West 39th Street New York	Monthly Per year $10.00
US-55	*Proceedings of the American Philosophical Society* 101 South Fifth Street, Philadelphia, Pa.	
US-56	*Proceedings of the American Society of Civil Engineers* 220 West 57th Street New York	10 Nos. per year Per year $8.00
US-57	*Proceedings of The Engineers' Club of Philadelphia* 1317 Spruce Street Philadelphia, Pa.	Quarterly Per Vol. $2.00
US-58	*Proceedings of The Engineers' Society of Western Pennsylvania* 2511 Oliver Building Pittsburgh, Pa.	10 Nos. per year Per year $5.00
US-59	*Proceedings of the U. S. Naval Institute* Annapolis, Md.	Quarterly Per year $3.00
US-60	*Professional Memoirs* Washington Barracks, D. C.	Bimonthly Per year $3.00
US-61	*Reactions* Goldschmidt Thermit Company 90 West Street, New York	Quarterly Per year $0.25

US–64	*Science Conspectus* Massachusetts Institute of Technology Boston, Mass.	Five issues per yr.
US–65	*Scientific American* 361 Broadway, New York	Weekly Per year $3.00
US–66L	*Scientific American Supplement* 361 Broadway, New York	Weekly Per year $5.00
US–68	*Seventh Regiment Gazette, The* 30 West 33rd Street, New York	Monthly Per year $1.50
US–71	*Stevens Indicator* Stevens Institute of Technology Hoboken, N. J.	Quarterly Per year $1.50
US–72	*Technical World Magazine* 5758 Drexel Avenue, Chicago, Ill.	Monthly Per year $1.50
US–73	*Telephone Engineer* Monadnock Building, Chicago, Ill.	Monthly Per year $2.00
US–74	*Transactions of the American Society of Civil Engineers* 220 West 57th Street, New York	Yearly Per year $12.00
US–75	*Transactions of the Society of Naval Architects and Marine Engineers* 29 West 39th Street, New York	Annual
US–76L	*Virginia Magazine of History and Biography, The* Virginia Historical Society Richmond, Va.	Quarterly Per year $5.00

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Bulgaria-Servia. Agreement between the general staffs, June 19, 1912—US-3L, Sup., January, 14.
Bulgaria-Servia military convention. June 19, 1912—US-3L, Sup., January, 14.
Bulgaria-Servia secret appendix, February 29, 1912—US-3L, Sup., January, 14.
Bulgaria-Servia. Treaty of alliance. Signed at Sofia, February 29, 1912—US-3L, Sup., January, 14.
Bulgaria-Turkey. Treaty of peace. Signed at Constantinople. September 16, 29, 1913—US-3L, Sup., January, 14.
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The responsibility of the Federal Government for violations of the rights on aliens—US-3L, January, 14.
Turkey-Balkan allies. Treaty of peace. Signed at London, May 30, 1913—US-3L, Sup., January, 14.
Turkey-Greece. Treaty of peace. Signed at Athens, November 11, 1913. With protocols annexed—US-3L, Sup., January, 14.
United States. Proclamation prescribing rules for the measurement of

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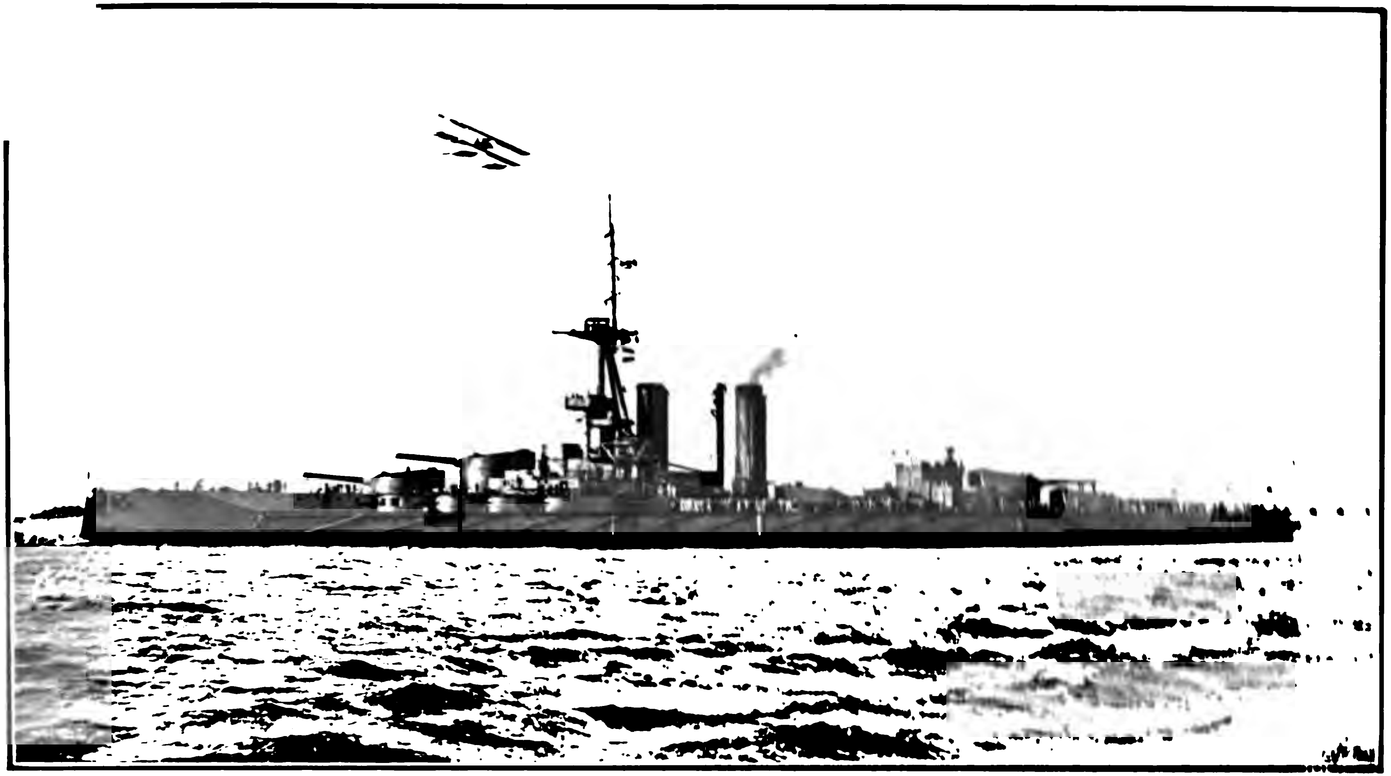
Page 298, line 24: - - For "30" read *.30*.
Page 304, line 33: - - - For "lower" read *upper*.
Page 306, lines 13 and 14: - For "to look downwards to" read *to look at*.

Frontispiece



Photograph by Stephen Cribb, Southsea.

H. M. S. "IRON DUKE"

Displacement, about 26,400 tons; length, (*water line*) 620, (*p.p.*) 590; beam, 89½. Armament: ten 13.5-inch; twelve 6-inch; five 21-inch torpedo tubes. Armor: belt, 13½ inches; turret, 10 inches; secondary battery, 8 inches. Designed horsepower, 33,000; speed 21 knots.—*Jane.* (See also page 300.)

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Second Prize, Essay Competition of 1913

A WAR CONDITION PERIOD AND HOW IT CAN BEST BE UTILIZED

BY 1ST LIEUTENANT FRANK S. CLARK, COAST ARTILLERY CORPS

The problem presented for discussion by this subject involves the consideration of two propositions which are clearly inferred from the wording and arrangement of the title itself. These propositions may be stated—

1. What is the proper *function* of a War Condition Period?
2. What is a suitable *program* for a War Condition Period?

The term "War Condition Period" first appears in the *Regulations for the Instruction and Target Practice of Coast Artillery Troops* for 1912, and both the term and the paragraph providing for it reappear in substantially similar form in the Regulations for 1913, paragraph 20 of which states as follows:

> 20. *War condition period.*—For all troops at their home stations one 24-hour period will be designated at least once during the encampment period, throughout which all fire-control stations in commission will be maintained under conditions approximating as closely as possible to those which would obtain in time of war. This period should be chosen at a time when Coast Artillery boats will be available for simulated naval attacks. Land and naval attacks may be conducted between posts in a coast defense command or between different coast defense commands when this can be done to advantage without hire of private transportation. With this end in view the exercises should be held at such times as to permit boats being sent from one coast defense command to another, care being taken not to interfere with the service of Artillery boats in connection with target practice. This war condition period will begin within 24 hours after the second service

practice.

From this it will be seen that the definite status of the Coast Artillery personnel and matériel called a war condition period has been recognized for but two years, and at present specifically provides for one 24-hour period during the encampment throughout which all *fire-control stations* shall be kept manned. Also, by rather direct inference, the use of Coast Artillery boats in making simulated naval attacks is prescribed. The simulation of land attacks as well, is recognized as desirable during this period, but is not enjoined.

While, in general, the initiative of coast defense commanders will elaborate these instructions to provide a more comprehensive test of the training of their troops, yet, in a consideration of the subject, it is worth while to note the very meagerness of specific instruction concerning it in the present regulations. What this may be due to, it is idle to conjecture; but, at least, no definite statement of the function of a war condition period is laid down in the regulations, and probably many officers in the Coast Artillery Corps are uncertain as to the real requirements of such a period, and what results are expected to be attained or can be attained from it. At present, the conception of the function of a war condition period and of the program to fulfill this function, may vary with each coast defense and each commanding officer. This uncertainty and diversity of opinion indicates the relative importance of the two propositions above stated for the discussion of this subject. For, before we can logically proceed to select from all the multitude of details possible to incorporate into a program for a war condition period those most valuable for a general scheme, we should examine the different ideas as to the uses a war condition period should serve, and, after a process of comparison and elimination, arrive at a definite notion of the proper function of a war condition period. Only then shall we have attained the right discriminative basis for the selection of details with which to construct a program.

1. *What is the Proper Function of a War Condition Period?*

From its very name, the intent of a war condition period is to place the personnel and matériel of a coast defense under more or less of the conditions that would exist during a state of war; and, as will be seen later, the question of the proper function of a war condition period is largely a question as to to what extent the conditions of war shall be simulated.

Before proceeding to a scrutiny of this question, it is highly necessary to investigate the problem and purpose of our coast defenses, and thence to determine the possible conditions a state of war might force upon us.

In the first place, the Coast Artillery officers who will be obliged to maintain a coast defense in time of war, cannot forget an essential fact which apparently the designers of the defenses did not consider. This fact is that in every naval operation from time immemorial against a coast fort, the principal burden of the attack has been borne, not by the warships, but by a landing force outflanking the position contained by the ships and seeking to overcome the fort by either assault or siege. (In this connection, see nearly every example quoted in *Artillery Notes No. 28—A Study of Attacks upon Fortified Harbors.*) Furthermore, from the very fact that our coast defenses are known to be detached batteries with their landward sides inadequately protected, we may be sure that any naval operations against one of our coast defenses will very early assume the form of a land attack. Therefore, one of the conditions that a state of war will impose upon an assailed coast defense may be surely assumed to be an immediate investment of the land side, which in many cases would mean the early loss of all communications and the necessity thereafter for dependence upon resources on hand for stores of all kinds.

It would be hard to overstate the importance of remembering always this phase of the coast defense problem. We are so occupied with the technical element of the problem, the skilful handling of our guns and accessories to develop their full fire-power, that that every-day concern looms before us so large as to obscure the tactical element of the problem, with the result that we are apt to neglect, until a time of war, preparations for that part of the struggle in which we should first be required to engage. General defense plans prescribe the procedure to cope with every form of purely naval demonstration or attack—reconnaissance, raid, run-by, bombardment. No provision, however, is made to resist the simultaneous or separate demonstrations or attacks that would be pushed in from the land side. In this peculiar obliquity of foresight the experience of every naval attack of a coast defense is wholly overlooked. We must remember that, if a hostile state is intent to secure for any purpose the harbor protected by one of our coast defenses, that state will not neglect to utilize every means which experience and judgment dictate as helpful to this end. We may be sure that, having pondered on our capture of Santiago, on Japan's capture of Wei-Hai-Wei, and again of Port Arthur, any state intending to sieze one of our protected harbors, will include in its plans for the attempt a strong force of landing troops, as a part of the initial expedition establishing the blockade.

Whether the idea is pleasing to us or not, in time of peace we should face the fact which in war we should be obliged to, that our task is measured by an even more complicated formula than can be stated in terms of azimuths, calibers, muzzle velocities, penetrations, recoils, volts, or candlepowers. Powerfully as we have forged the forces of nature into weapons for our hand, we cannot with these weapons keep an enemy at arm's length, unless by some magnetic influence we can compel him to keep in front of us and within the sweep of these weapons. Until we can cover our backs with the same formidable enginery wherewith we now arm our fronts and faces, we must be prepared, in fort as well as in field, to play the part of men, and stake our successful defense on the ancient qualities of endurance and prowess in our men, and courage and determination in our officers.

Indeed, no matter how much in future the land defense of our coast forts may be improved, no matter how large the force of Coast Artillery Supports sent to aid us in time of war, yet still would remain the stern requirement, under the stress of siege, for Coast Artillery soldiers to lie in trench and die as cheerfully by bullet as by shell. And why not? No matter who or how many are sent to help us, are not these *our* forts, in which we alone always live—they always fixed to us and we to them? The land defenses of Port Arthur were manned by Rifle Brigades, but did artillery, and even sailors from the fleet, fail to die in the trenches?

It is not the intent of the foregoing observation to glorify blind and altruistic immolation, only in so far as such sacrifice would enhance military success, and only in so far as to emphasize that the proper furnishing of our officers and men should include an appreciation of the possible necessity for this sort of personal sacrifice. In time of peace, by accepting service in our Coast Artillery, we should accept with it, and make the best of, the condition we know to exist—that, through no fault of our own, our coast defenses are not designed with sufficient strength on their land fronts.

Whatever may have been the purpose intended in the establishment of the particular coast defense of which we may at any time be a part, it is not our business to know, only in so far as the knowledge of the purpose of the coast defense will enable us to determine the length of time it must be held. For in all our coast forts a *definite* appreciation should be had by all as to the length of time the forts must be held, and the necessary stubbornness and sacrifice to attain this end. Plans should be laid to hold the positions, not "as long as possible," but definitely for so many months, the preconceived period being sufficient to meet any strategic requirement possible, taking into consideration all the conditions of the location of the coast defense, strength massed against it by a possible opponent, the probable political condition in the United States, and the operations of our own forces in other parts of the country. When this ulterior limit of time has been established for each coast defense by the highest authority, all plans should be made upon that basis. Notwithstanding their present inadequacy, nothing less will do than to conceive of most of our coast forts as *fortresses*, and, accepting that conception, to be prepared to convert and defend them as such. No half-hearted measures will stand the test, as Russia learned by the ordeal of Port Arthur. In his keenly critical review of that struggle under the title of *The Influence of the Experiences of the Siege of Port Arthur upon the Construction of Modern Fortresses*, A. Von Schwartz has set forth in forceful terms the many lessons taught by the siege, and among the most important is the lesson of what constitutes the purpose of a fortress. His argument is convincing. There is room here for but a brief extract from his words.

> Fortresses have existed since the most ancient times and will ever continue to exist for one purpose only, the "stubborn defense of a given point." The shape of fortresses has changed, as well as their dimensions, armaments, garrisons and outworks, but their purpose cannot change. The "point" and the "fortress" must not be confounded. The value of a point may change. To-day it is important for political reasons; to-morrow its political importance may have passed away and it may have only a commerical importance; later its strategic importance may be recognized; etc. The value of the point depends on various circumstances, but the object of its fortifications will always be the same. Only with a change in the importance of the point can the shape and extent of the fortifications be changed.
>
> We therefore arrive at the following definition: "The purpose of a fortress is to assist in the stubborn defense of a given point until the end of the war."
>
> The principal thing which was, is, and ever shall be demanded of a

fortress is the stubborn defense until the end of the war of a point which the country has found necessary to hold and has fortified for this purpose. It is this purpose which must be considered in the planning and construction of fortresses. This is the indispensable requirement calling for their erection and is the whole object of their existence.

It is not alone for the rational construction of fortresses that it is necessary to have a clear conception of their purpose. It is equally important that the commandants defending them be thoroughly penetrated by this idea, and that they adopt no other. If Marshall Bazaine had grasped this idea, if he had understood clearly the purpose of the fortress which he commanded, he would never have said that once Paris was blockaded, Metz had played out its rôle, that it was no longer necessary, and could be surrendered. So also with Port Arthur. It could not be inferred, when the concentration of Kuropatkin's army had been completed, that the rôle of Port Arthur was at an end.

General Leer has said that "To name a thing right is to understand it right." As the correctness of action depends upon correctness of understanding, we shall paraphrase General Leer's aphorism as follows: "To name a thing right is to understand it right and to use it right." Therefore it is most important that those who construct and those who command fortresses should understand once and for all that the purpose of a fortress is "To assist in the stubborn defense of a given point until the end of the war." Then only will fortresses be properly constructed and properly defended. (Pp. 174, 175, 176.)

In brief, the conditions imposed upon a coast defense by a state of war will frequently include close investment on the land side as well as bombardment and harassment from the sea side, the loss of communications and the consequent hardship and privation due to a lack of supplies. The coast artillery garrison will have to do double duty, for the troops attached as supports will be too few. As losses occur, the duties of all will become more onerous, as the defense must be maintained without reinforcements. All must be prepared to continue the resistance to utter exhaustion of strength and of munitions, in order to overcome the inadequate preparation of the position and enable the defense to last long enough to fulfill the purpose for which it was established. Such then, being the possible conditions of war, what is the relation thereto and what the proper function of a war condition period?

As was earlier asserted, the intent of a war condition period is to place the personnel and matériel of a coast defense under more or less of the conditions that would exist during a state of war. This is the intent, but what possible purposes can such a procedure serve? Broadly speaking, there are but two such purposes—the purpose of additional *instruction* of the personnel, or the purpose of a *test* of the personnel, matériel, and plans. In the discussion of this subject, the selection of one of these conceptions as to the proper function of a war condition period is the vital point at issue. Which shall it be?

Do we need to add anything to our curriculum in the shape of another form of instruction? Is our yearly program varied enough to give our men all the different kinds of instruction they can properly assimilate? Will this addition to the program stimulate interest in any of the present subject-matter of instruction?

On the other hand, do we know what our men can do under the stress of anxiety and fatigue? Do we know whether our guns can continue effective fire if a land attack is in progress behind them? Have we *any* comprehensive test of what our whole system will do under the strain of service? If a war condition period can be made to give such a test of our system, would it not be worth while, and could not the results be applied to correct hitherto unsuspected faults in our plans and our *instructional* work? Even if a war condition period should be valuable as an *instructional* method, would not its value as a *test* still be the greater?

Under ordinary conditions, when we fire a service practice, we lay aside infantry drill, fatigue work, small arms instruction, even filling projectiles and guard duty. While we are on the small arms range, we leave the battery at rest. When we march and maneuver as infantry, we also lay aside blue denim and leave the guns alone. When we draw clothes, dig trenches, or handle commissaries, we expect that everyone will surely have a rest before firing a night practice. Indeed, we would not do any of these things on the day preceding a night practice. There is no one who knows what figure of merit would be obtained by our present "Number One" companies if, before firing their day practice, they were required to fire a night practice, then double-time to a line of trenches, there pour in a hot small arms fire till after dawn, and then hurry back to the battery to fire the day practice.

In our instructional work of every kind we carefully eliminate variants and causes of error so as to determine the degree of progress in the particular form of instruction being conducted. This is necessary and proper. Now if we are pleased to utilize a war condition period as a *test*, it can be made to give an algebraic summation of *all* variants and errors with our system working as a whole—in full blast, so to speak. Whether or not the use of a war condition period as a part of the instructional program is worth while, is not a question here to be decided. On the other hand the desirability of testing our men, our guns, and our methods as a war unit appears so obvious, and the ability of a war condition period to serve this function can be made so unmistakable, that, if we are to have war condition periods at all, there can be no uncertainty in declaring that the preferable conception of the use of a war condition period is as a *test* of the coast defense as a whole.

The difference between the uses of a war condition period under the two conceptions can well be illustrated by an incident observed during one of the recent maneuvers in the District of Luzon. One detachment, consisting of several infantry regiments with a battalion of field artillery and a squadron of cavalry attached, was advancing to a river crossing which would probably have to be forced. A low ridge extended toward the river at an oblique angle to the river's course. The main body was advancing behind the shelter of this ridge, and, just as it was about to cross the ridge and descend toward the river, the advance guard, which had already passed the summit, was attacked and driven back; while almost at the same time a heavy enveloping fire was poured in on the main body from the left flank, and soon the rear guard even was engaged against hard-riding hostile cavalry. A most beautiful position for field artillery was to be had in a basin just behind the ridge near the head of the main body, with the possibility of sweeping every portion of the attack by indirect fire. The artillery was ordered up at a trot to this position. Then, it seems by a mistake in orders, one battery went into action, not having been ordered by the battalion commander but by some officer on the staff of the detachment commander. At the sound of the first shot, the artillery battalion commander rode back from his position near the head of the column, ordered the battery to cease firing, assembled all the battery commanders and battalion staff, and while the mêlée raged on all sides, undertook to ascertain by whose orders the battery had gone into action and in positive terms instructed his officers that such procedure was wrong and that in future all orders to any battery must come through the battalion commander. By this time the chief umpire had stopped this phase of the problem; so that, as a net result, one opportunity for artillery to work out its function of helping the infantry was wholly lost. Considered only from the standpoint of the instruction of his battalion, the action of the artillery commander was necessary and proper. If, however, the conception of such a maneuver is, instead, the instruction or test of the *whole force* of all arms, then his action was untimely; for, if he had taken such action during a battle, the assistance of his artillery would have been lost. Furthermore, it is to be supposed that in battle, whatever mistakes may be made, and however peace-time instruction may be violated, it is the duty of everyone to fit in and make the best of any situation—at any cost to keep going. What was the accepted conception of the maneuver referred to, I do not pretend to say; but the occurrence may serve to show that in planning and executing a war condition period everyone concerned should know beforehand whether in case of mistake or mishap he should stop to correct it, or whether he should keep on going and do the next best thing, which is what a condition of war would demand.

All this discussion of the *function* of a war condition period is fundamentally and primarily necessary to the solution of the problem; and, if by its means the conception of this function now appears properly to be that of a comprehensive *test* of our whole system, then we are in a position to proceed to the second of our main questions.

2. *What is a Suitable Program for a War Condition Period?*

Even though we have a clear idea of how a war condition period should serve us, in order to gain the desired result a program must be planned for it which will insure that, at some time during its course, the desired test shall be obtained of every element in the coast defense. It is not properly the province of this essay to lay out in detail the items and events, and their sequence, which should go to make up the program for a war condition period. No two coast defenses have the same problem, and consequently for no two coast defenses should a war condition period be carried out in the same way. Furthermore, for any one coast defense, successive war condition periods would not require the same program; for, as a result of the first carried out, observed deficiencies would be corrected and the coast defense plans modified, so that a later war condition period should provide a more rigorous and comprehensive test than the first. It is, however, highly desirable to enumerate in this paper certain general principles which should govern the formulation of such programs, in the light of our conception of their function.

In the first place, the war condition period should extend over a sufficient length of time to constitute a real test of the elements of fatigue, morale, internal resources of the place, etc. A careful observation of conditions obtaining during the extensive maneuver mobilization on Corregidor in 1913 constitutes a basis for the firm conviction that it is impossible for a war condition period to fulfill its function if its operations do not control the entire life of a coast defense for at least one month. The situation is slightly analogous to the training of a soldier in the art of individual cooking. Let the company march out with the materials for a single meal, and even if the soldier makes a sorry failure of this meal, the event leaves no serious impression on his mind, for he knows that in a few hours he can make amends to his stomach with the usual fare of barracks. However, let the man know that for several days his meals will depend wholly upon his own skill, and the chances are strong that the preparation of the third meal, if not of the second, will involve his most serious attention. So, in the conduct of a war condition period, if everyone feels that at most there are but two or three days and nights of fatigue and sleeplessness, the realization of the coming rest and resumption of ordinary routine will operate to forestall any serious consideration on the part of officers or men as to what methods they should adopt to conserve their energy if called upon to withstand a prolonged siege. Whereas, if all realized that a whole month of probable hardship was ahead of them, the effort to withstand the fatigue would immediately constitute a problem to which every mind would devote its most serious attention.

As a second principle, it is believed that a month out of every year would take an unwarranted amount of time away from other duties; and moreover, that such a comprehensive test as is contemplated is not necessary nor desirable every year. Therefore, it is proposed that a war condition period should be held in each coast defense once in four years (with the enlistment period as it is at present). This would result in every soldier of the Coast Artillery passing through this experience once during his original enlistment. This arrangement would have further advantages. The Coast Artillery Reserves assigned to a coast defense could take part in it during their annual tour of duty, to their advantage, and without undue prejudice to their usual instruction. Again, by properly alternating the years in which war condition periods should be held in the various coast defenses, it would be a practicable arrangement, when one coast defense was holding its war condition period, for the troops of one or more adjacent coast defenses to perform their yearly field duty as infantry acting as a besieging force. By this means, the Coast Artillery would surely learn its lesson well, because in time, every officer and man would meet the problem from both sides—as besieger and besieged.

A third principle which is important is, that if the conditions in the particular coast defense are such that during war it would be cut off from all outside communications, it should be so cut off during a war condition period. This means, for instance, that if there are babies living in the post for whom a supply of milk must come daily from a mainland dairy, during a war condition period the babies should be moved to the mainland. It means that no passes should be granted, and that for the time being the ball team from the near-by town must needs stay away. It means that if fresh beef could not be brought to the post after investment in war, during a war condition period bacon and canned beef should be the rule. Such deprivations would not be meaningless and arbitrary. The significance and value of a war condition period will be lost if it be not consistently, compellingly complete.

A fourth principle is that the program should include items calling for some performance by the personnel in every sort of duty for which Coast Artillery is trained—service target practice, mine planting and mine practice, small arms firing, service of searchlights, firing with field and siege guns, infantry attack and defense, reconnaissance, and outpost duty. The idea should not be to have these events follow in any sequence known to the personnel of the coast defense, but unexpectedly, one thing following another as measures of resistance to the operations of an active and resourceful enemy. This points to the desirability of having such a program devised, not by the coast defense commander, but by higher authority, preferably by the District commander, who should, however, be guided by previous recommendations of the coast defense commander as to elements of the defense particularly requiring trial and test. By providing that each boat used in the problem to simulate a hostile naval vessel should always tow a target, every combination of fire control plans could be tested out during the course of the exercises, with the ability to turn loose any battery, at any time desired, with actual gun fire, without any previous intimation to the battery commander. Where local conditions would demand it in war, during the war condition period all these service practices should be battle command, fire command, or emergency practices—at any rate, *tactical* practices in distinction from *technical* practices. Likewise, where safely possible, small arms firing for results should be unexpectedly required as the solution of some phase of the problem.

A fifth general principle is that the war condition period should proceed through its course for twenty-four hours a day, with no limitation nor respite granted to the personnel by prearrangement during which they might feel secure from attack. It would be true of the simulated attacking force, as of an attacking force in war, that from their own necessity for rest and replenishment they would afford occasional respite to the besieged, but this ability to select the times when operations will be suspended and resumed, is one of the advantages which always remains with the offensive, and the existence of which spells no small part of the problem of the defense.

The foregoing cover the important principles to be fulfilled; but it is to be observed that there are many determinations which a well devised program would serve to attain. Some of these may be enumerated.

A very satisfactory determination should be obtainable as to the exact effect of exhaustion and sleeplessness on the accuracy of our fire control methods and artillery firing.

The actual war requirements for special-duty men could be determined, and the necessary modifications of post routine and administration could be ascertained and the whole tabulated for future use.

A war condition period would decide the practicability of the details of Battle Orders and General Defense Plans.

A definite idea might be obtained as to the nature and extent that removal or use of private property in the vicinity of the coast defense would be required in time of war.

In many cases the visibility of barracks, storehouses, camp sites, roads, railroads, etc., would develop in its true light as a matter of importance—a matter perhaps now too lightly considered.

In many coast defenses the question of the protection of water supply would loom up in the proportions of its real importance.

The whole question of the number and use of Coast Artillery Supports is now largely a theoretical one. One or more war condition periods in each coast defense would probably afford exact data on the subject.

The problem of local reconnaissance is now possibly too little considered. A war condition period should develop the use of all available resources—telephones, natural look-out stations, cyclists, motorboat patrols, radio, etc.

Certain phases of a war condition period could be made use of to familiarize the troops with hand grenades and rifle grenades, and their effectiveness, so that in war these devices would not prove unfamiliar weapons in their own hands nor unknown and terrifying agents of destruction in the hands of an enemy.

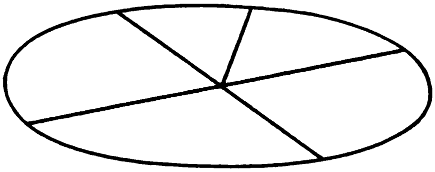


Fig. 1

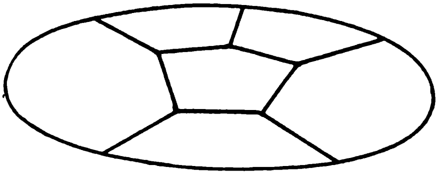


Fig. 2

The division of a coast defense into land defense sectors is a somewhat nebulous proposition in the minds of many officers; at least, many post graduate school discussions would so indicate. What is the proper relation of sectors and sector commanders to each other and to the whole land defense scheme? Should the size of sectors be regulated by the number of troops to be assigned to them, or should the number of troops be regulated by the size of sectors? What is the proper way to use reserves in land defense operations? For instance, in a coast defense occupying an elliptical island, should the sectors be arranged as in Fig. 1, each sector being provided with its own share of the reserve, and charged with the defense, not only of the shore line, but of every inch clear to the center of the island; or as in Fig. 2, with a central reserve sector, an *enceinte*, in principle if not in fact?

Now, of all such questions there is a practical and definite solution; but until the problem has been thoughtfully worked out through the agency of some such matter-of-fact effort as a war condition period, any solution must remain theoretical and unproved, instead of practical and certain.

It is to be noted that the *program* for a war condition period should *not* properly include the details of *organization* for the artillery and land defense of the coast defense. The war condition period will test the efficiency and completeness of such organizations; but the organization itself should be, and doubtless is, a matter of permanent peace-time record, as outlined in Captain Shartle's discussion on the subject of "Plans of Defense for Artillery Districts," in Volume 32 of the JOURNAL OF THE U. S. ARTILLERY.

Before concluding this discussion, it behooves the writer to state that in the five general principles enumerated above as the guiding elements in the construction of a program for a war condition period, he is as keenly aware as any reader can be that these dicta compose a veritable Spartan pronouncement, wholly radical, and constitutionally opposed to the attitude of the normal American, patriotic and red-blooded though he be. The American soldier shares with the British soldier a traditional repugnance to exceptional severity in the details of his peace-time training; and, because these cousins are *volunteers*, their prejudices are respected and their whole scheme of service is less thorough-going and more amateurish than is tolerated in the short, sharp grind of a conscript's training. Yet we believe, and history affirms, that the American and the Briton hold in their spirits the eternal readiness for the ultimate sacrifice when the demand of conflict requires it. Our satisfaction in the inner timber of our men should not, however, blind us into a complacent acceptance of our peace-time inertia and unreadiness to pursue our training methods to the limits of rigor and completeness. We are all ease-loving and somewhat indolent. This attitude toward life is pleasant and in itself not to be condemned, for indeed it is our natural heritage. Verily, the attitude is not to be condemned, but the surrender to it most heartily is. There hangs over us always a possibility which commonly we cheerfully ignore. This possiblity is the likelihood that in war our losses in men will be greater by far to accomplish the same result than need be the case if all our preparation was wholly thorough. True, it is noble to be a dead hero; but how much preferable it is to go into a conflict with the adequate skill to win and yet to survive. From this standpoint, an occasional procedure which, while entailing inconvenience and hardship, yet enhances our chances in the supreme test of war, is to be considered, even by an American, not only tolerable, but desirable.

A war condition period properly conducted can be made to serve such a purpose. Its function of *testing* all our system and arrangements will serve to reveal to us our weakness and error at a time when that weakness and error are not fatal, because opportunity then exists to remove the weakness and correct the error. The hardship at which the soldier demurs is the unmeaning hardship, that which results from the carelessness of his superiors and conduces to no good purpose. The man who cannot endure a war condition period cannot endure a war, and should be revealed and removed as a weak link in the system. For the satisfaction of the participators, it is most fitting that a war condition period should be so thoroughgoing and so unmistakably a likeness to the condition of war that the relation of the counterpart to the real thing can be clearly seen.

On this high ground, we stake the good sense of our belief that a war condition period is valuable, if it be conceived as a test and be executed at not too frequent intervals with such thoroughness—cutting deeply into the fabric of our lives, routine, schemes and training—that it will be in fact as well as in name, a War Condition Period.

experienced with these carriages, due to their failure to recoil uniformly, thus interfering with the ease of loading, and due also to over-recoiling, the carriages being damaged by the top carriage striking the hurters with great violence. These difficulties were largely due to the attempt to use different weights of projectiles and different velocities with the same gun and carriage, which with the simple recoil system referred to above caused great variations in the recoil. The suggestion was made, in connection with this design of carriage, that it was considered entirely practicable to control the recoil by greasing the rails of the chassis for light powder charges and low velocities, and by throwing sand on the rails for the heavy powder charges and higher velocities. This difficulty in controlling the length of recoil brought the first big improvement in these carriages, which was the development of a pneumatic buffer to provide a cushion at the end of recoil. This improvement, however, was not made until about 1873. In Fig. 1 is shown a carriage of this type. The pneumatic buffer is the large drum-like device at the rear of the chassis.

The change from a device which would simply stop the carriage at the end of recoil and prevent damage, to one which would control the movement of the carriage throughout recoil, was the next most obvious change required in the seacoast carriage. The hydraulic recoil cylinder was the next improvement introduced.

The early types of recoil cylinders were very crude in design, due to the fact that the laws controlling the resistance to the flow of oil through the variable orifices was not as fully developed as it is at the present time. In fact, it is only within the last three or four years that the variations in the coefficient for contraction of the liquid vein due to changes in velocity and pressure in the cylinder have been investigated sufficiently to enable thoroughly satisfactory pressures in recoil cylinders to be obtained.

In the design of a hydraulic recoil cylinder, the object to be attained is so to adjust the throttling areas that either a uniform pressure or a certain desired variation in pressure is obtained. In the usual case of a barbette carriage or of a disappearing carriage with cylinders in the top carriage, a uniform pressure throughout the length of recoil is desirable, so far as the stresses on the carriage are concerned. In the vertical cylinder of seacoast carriages it is possible to increase the pressure at the beginning of recoil and diminish it toward

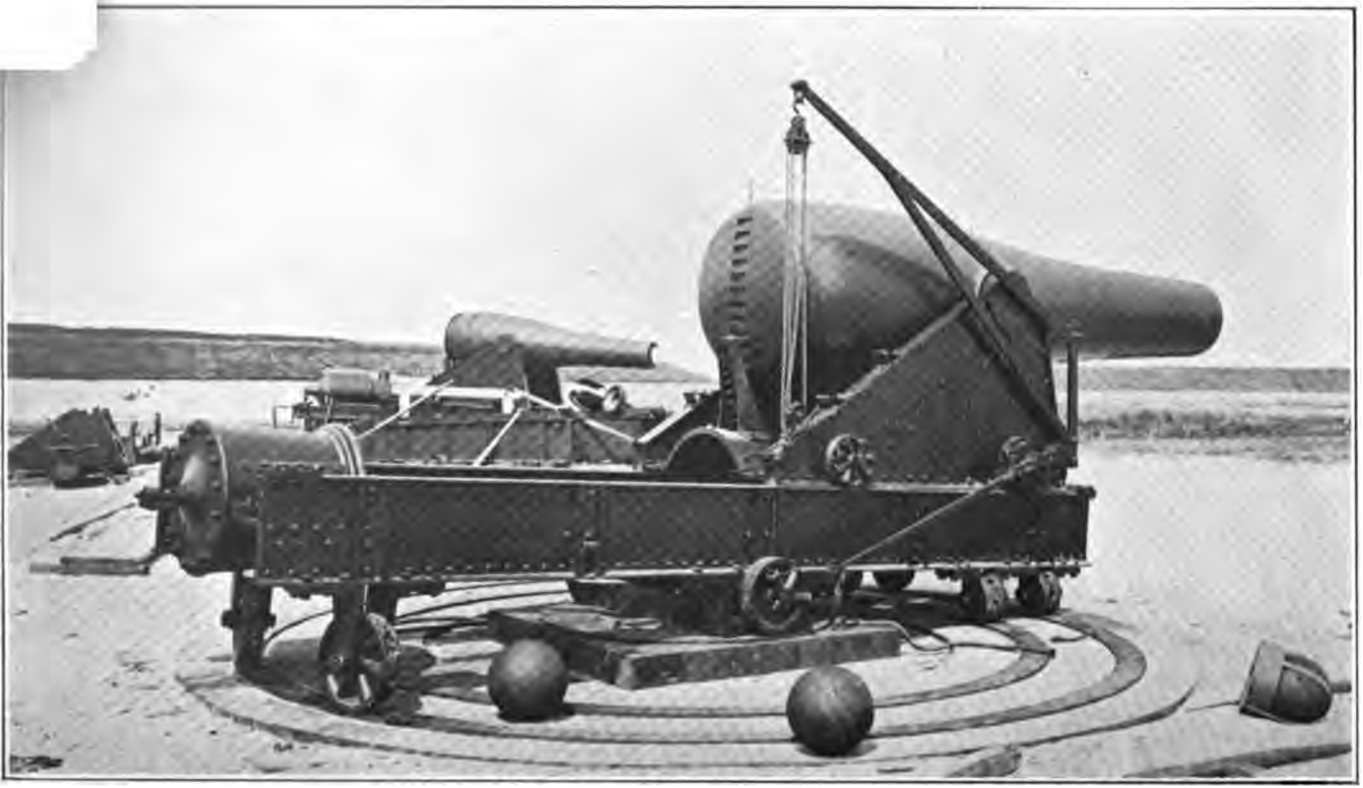


FIG. 1.

15-inch muzzle loading smooth bore gun on barbette carriage with pneumatic buffer; center pintle.

the end of recoil with a reduction in the stresses on certain parts of the carriage. In some of the howitzer carriages it has been found desirable, in order to increase the stability of the carriage, to have the pressure in the cylinder greater at the beginning of recoil, when, due to the weight of the gun in battery, the conditions for stability are better than towards the end of recoil, where the stability is reduced by the displacement of the recoiling parts in the recoil of the gun. In the present state of calculation of the throttling areas it is possible to take all of these points into consideration.

Until 1873 all seacoast carriages had been either of the barbette or the casemate type. In that year a special board, known as the French Board, was convened for the purpose of considering new designs of seacoast guns and carriages. From an examination of the design submitted to this board it appears that a great many officers had become convinced that sufficient protection for the gun and carriage was not secured with the ordinary barbette or casemate carriage, and a number of designs were submitted to this board for carriages of the semi-disappearing type.

Among these may be mentioned the counterpoise carriage invented by Captain W. R. King, in which the top carriage recoiled on an inclined chassis sloping downward to the rear. It was held in that position under cover by pawls until the gun was loaded. The release of these pawls permitted the carriage to be returned in battery by a counterweight. This carriage was built and proof-fired nearly a hundred rounds satisfactorily.

There was also submitted to this board a design of a carriage called the "Buffington Depressing Carriage." This was the forerunner of the present Buffington-Crozier disappearing carriage.

This carriage was first proposed in 1872, by the late Brigadier General A. R. Buffington, and is described and illustrated in the report of the Chief of Ordnance for 1873.

It will be noted from the picture that in its earliest form no hydraulic brakes and no accurate means for traversing, elevating, or depressing, were provided. No practical use was made of this type of carriage until some twenty years later, when General Crozier, then a captain of ordnance, appreciating the possibilities of such a mounting, redesigned the carriage, adding hydraulic recoil cylinders to the top carriage, and providing means for accurately laying the gun in elevation and azimuth. The first disappearing carriage was designed to mount an 8-inch rifle, model of 1888, and was, like the design first proposed by General Buffington, of the front pintle type.

The earliest design is known as the Disappearing Carriage Experimental. (Fig. 3.) It will be noted that it bears a very close resemblance to the model of 1894, 8-inch and 10-inch disappearing carriages. (Fig. 4.)

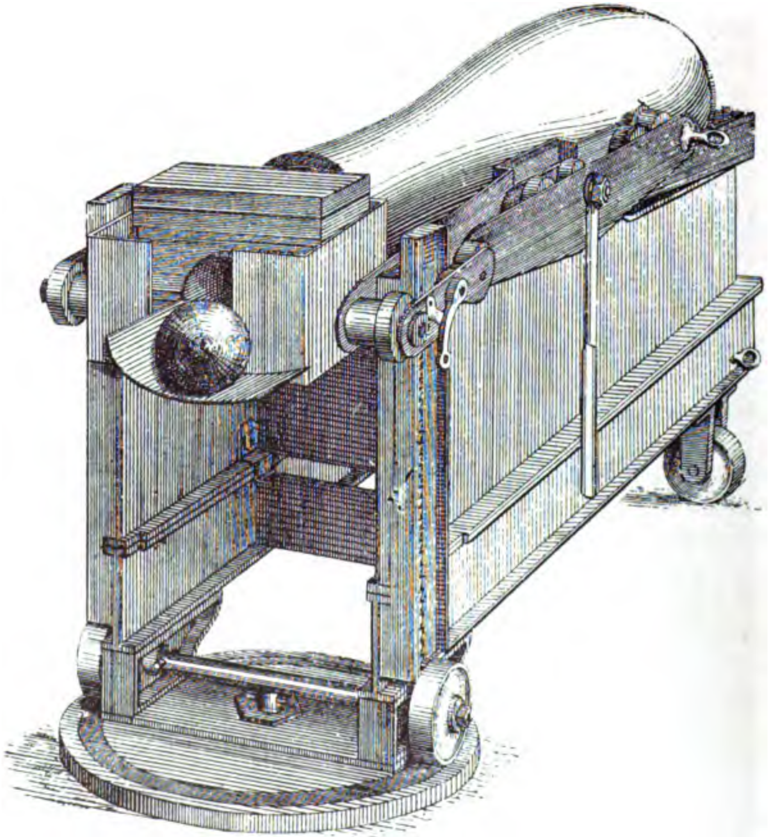


Fig. 2.

Buffington depressing carriage.

Very little was known in this country about disappearing carriage design at that time; so the methods of computation were necessarily original with General Crozier. As time passed, the original type of disappearing carriage was modified in some of its details. In the 10-inch disappearing carriage, model of 1896, the front pintle was abandoned and the whole carriage mounted on a simple circular base-ring. This type of mounting has been used on all the disappearing carriages since that date, except the all around fire type, model of 1896, which was designed to fit certain special localities where a large traverse was desirable.

Up to the time of the adoption of the vertical recoil cylinder, which appears first in the 6-inch disappearing carriage, model of 1905, the improvements in the disappearing carriage were largely refinements in design. The reasons which led to the change from the cylinders in the top carriage to the vertical cylinder in the counterweight, are of considerable interest.

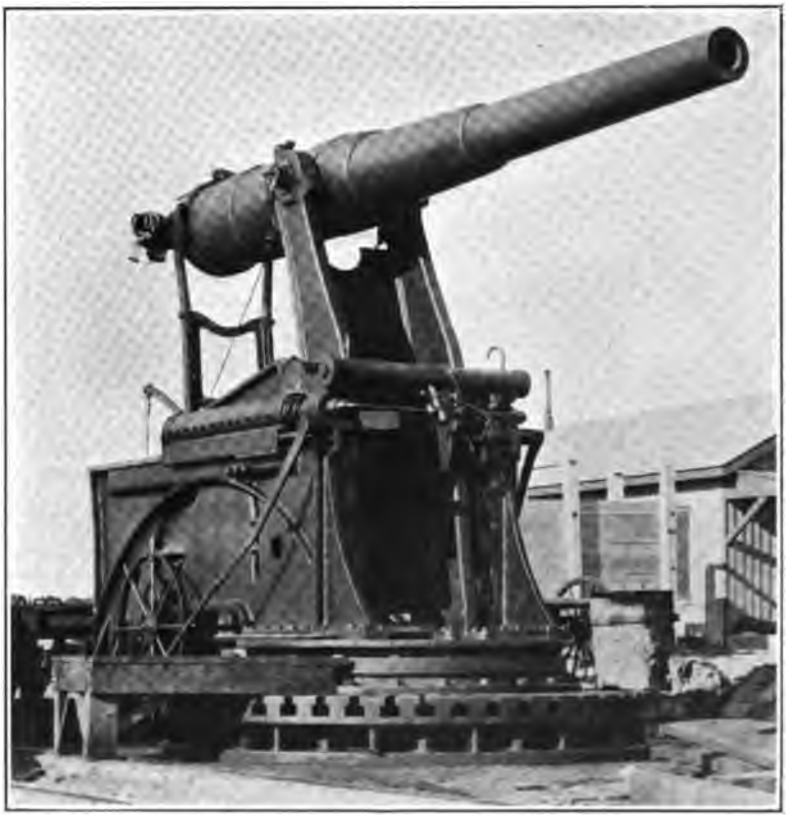


FIG. 3. 1145

Experimental Buffington-Crozier carriage for 8-inch B. L. rifle. (Front pintle retained; hydraulic recoil cylinders added.)

In the design of a recoil cylinder, in addition to the variable clearances which are provided by the throttling bars or throttling grooves, there are certain constant clearances which are necessary for proper working, such as that between the walls of the cylinders and the piston heads. In cylinders of the diameter necessary in disappearing carriages, this clearance, while extremely small, being only 1/100 radially, amounts, when multiplied by the circumference of the piston, to a considerable area. Consequently, unless the velocity of the top carriage is considerable, but very little pressure is developed in the cylinder. Near the end of recoil, the top carriage gradually loses its velocity, and the resistance in the recoil cylinder decreases to practically nothing. There may be, however, considerable energy left in the gun and in the counterweight, with no resistance opposing their motion except the friction between the crosshead and crosshead guides and between the top carriage and the chassis. This accounts for the occasional difficulties which are found on disappearing carriages in controlling the length of recoil. The remedy for this variation in recoil is the vertical cylinder in the counterweight. With this it has been found possible to fire large numbers of rounds with no variation whatever in length of recoil. It has also been found that large variations in temperature have practically no effect on the recoil. Moreover, it is possible

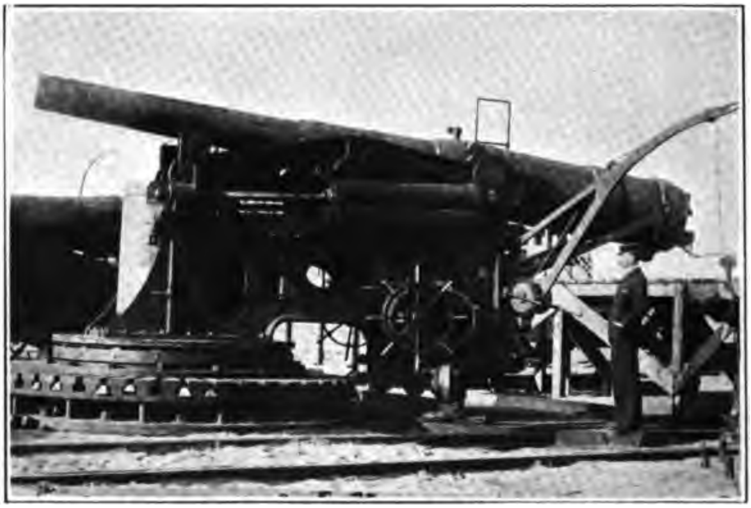


FIG. 4. 1446

Earliest model of Buffington-Crozier carriage issued to the service: for 8-inch rifle.
(Chassis, elevating rack, and recoil cylinders redesigned.)

with this type of cylinder to provide a dashpot action at the end of recoil, which effectually prevents over-recoil, even though the throttling valve be erroneously set.

This carriage, however, has certain disadvantages: there are mechanical difficulties in assembling the long cylinder in the center of the counterweight and providing for the attachment of the piston rod to the fixed parts of the carriage; the recoil cylinder, being enclosed in the counterweight, is not as accessible for examination as in the older type of carriage; the pressure on the crosshead guides is much higher with the vertical cylinder carriage during the latter part of recoil than with the older form of carriage; and this, with the method of connecting the piston rod to the bottom part of the chassis, produces more overturning moment on the carriage and requires heavier holding down clips at the front of the carriage. On the other hand, the older form of carriage has very little pressure on the crosshead guides after the first instant of recoil, while the powder gases are acting. In the vertical cylinder carriage pressure on the guides is as indicated by the curve in Fig. 5. Providing for this heavy bearing pressure neces-

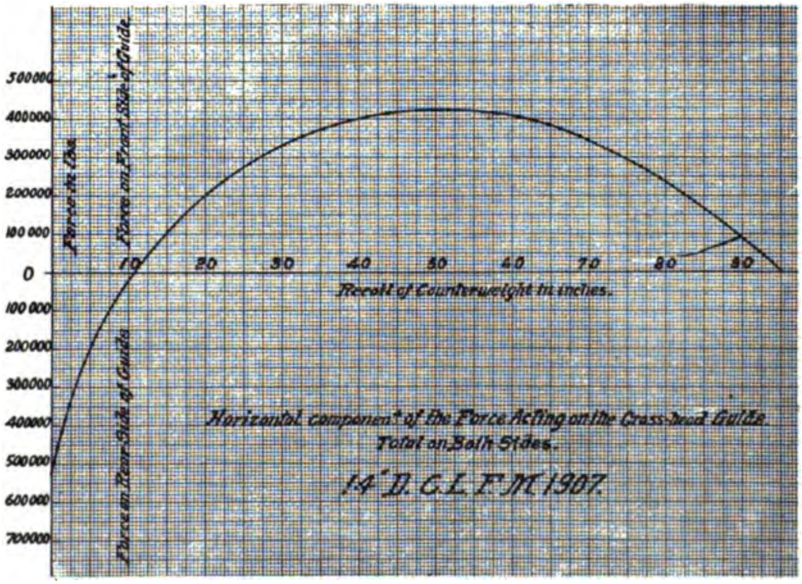
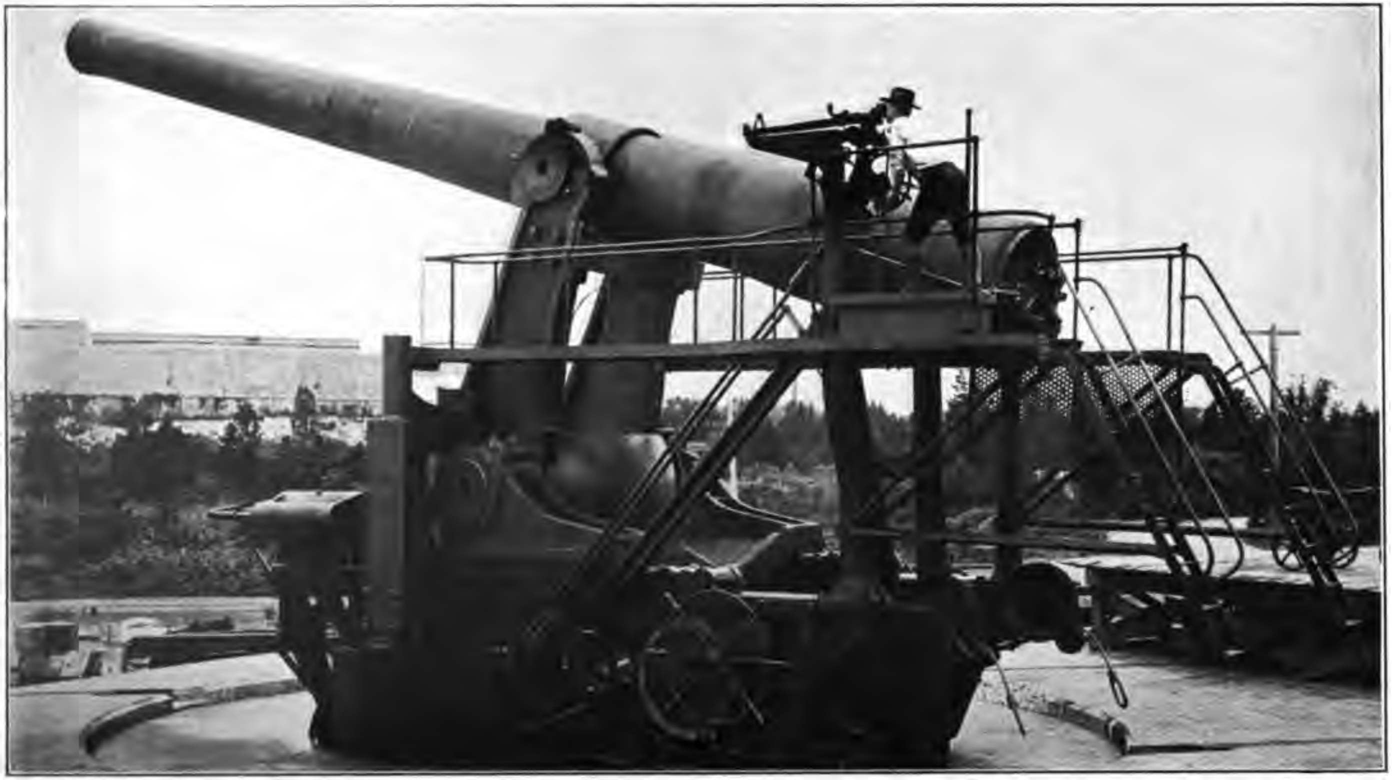


FIG. 5. 1447

Pressure on crosshead guides: vertical cylinder carriage.



1215

Fig. 6.

Model 1907 carriage, L. F., with vertical recoil cylinders: for 14-inch rifle.

sitates particular care in lubrication of the crosshead guides of vertical cylinder carriages, and also special attention to the fastenings of the upper ends of these guides.

Up to the present time, the only carriages of the vertical cylinder type that have been manufactured are the 6-inch disappearing carriage, models of 1905 and 1905-MI and MII, and the 14-inch disappearing carriage, models of 1907 and 1907 MI. (Fig. 6.) The new 16-inch carriage, which is now under manufacture, will have both horizontal and vertical cylinders. The vertical cylinders on this carriage, however, will not come into action until the last eight or ten inches of recoil, and are added principally for the purpose of stopping the movement of the gun and counterweight after the horizontal cylinders cease to act. It is believed that this will give uniformity of recoil equal to that obtained with the 14-inch disappearing carriage.

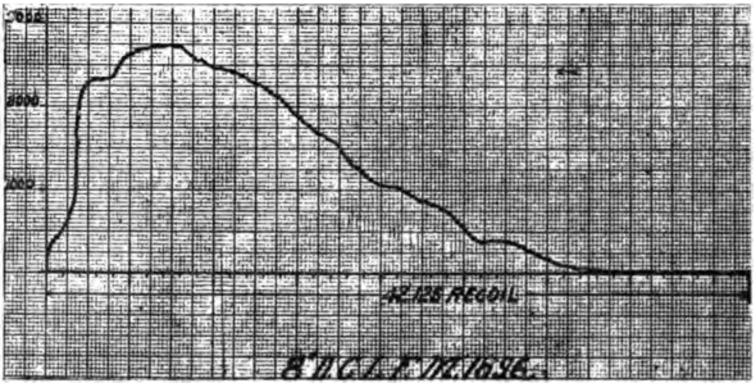
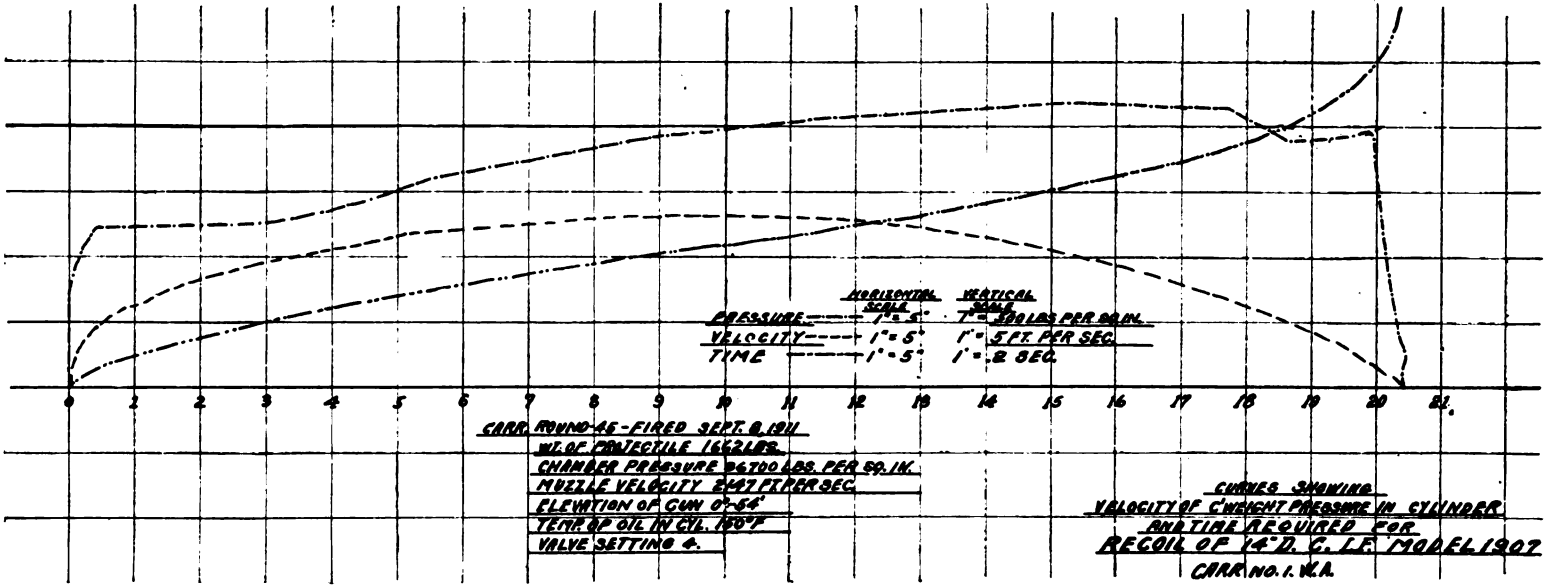


FIG. 7. 1148

Pressure in recoil cylinders of the older carriages.

In the older carriages, the throttling bars were designed before the present knowledge of throttling areas and construction of the liquid vein. The curve of pressure in the recoil cylinder, as determined by indicator cards, appears as shown in Fig. 7. The area under this curve represents work done in stopping the carriage and shows that practically all of the work is done in the first part of recoil. But, as stated before, the counterweight continues to rise and the gun continues to drop for some time after the velocity of the top carriage has been materially reduced, when, owing to the low velocity of the top carriage and the large throttling areas in action, very little con-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HORIZONTAL SCALE
VERTICAL SCALE
PRESSURE —·—·— 1" = 5" 1" = 300 LBS PER SQ.IN.
VELOCITY - - - - 1" = 5" 1" = 5 FT. PER SEC.
TIME —··—··— 1" = 5" 1" = .2 SEC.
CARR. ROUND-45-FIRED SEPT. 8, 1911
WT. OF PROJECTILE 1662 LBS.
CHAMBER PRESSURE 36700 LBS. PER SQ. IN.
MUZZLE VELOCITY 2147 FT. PER SEC.
ELEVATION OF GUN 0°-54'
TEMP. OF OIL IN CYL. 150°F
VALVE SETTING 4.
CURVES SHOWING
VELOCITY OF C'WEIGHT PRESSURE IN CYLINDER
AND TIME REQUIRED FOR
RECOIL OF 14" D. C. L.F. MODEL 1907
CARR. NO. 1. W.A.

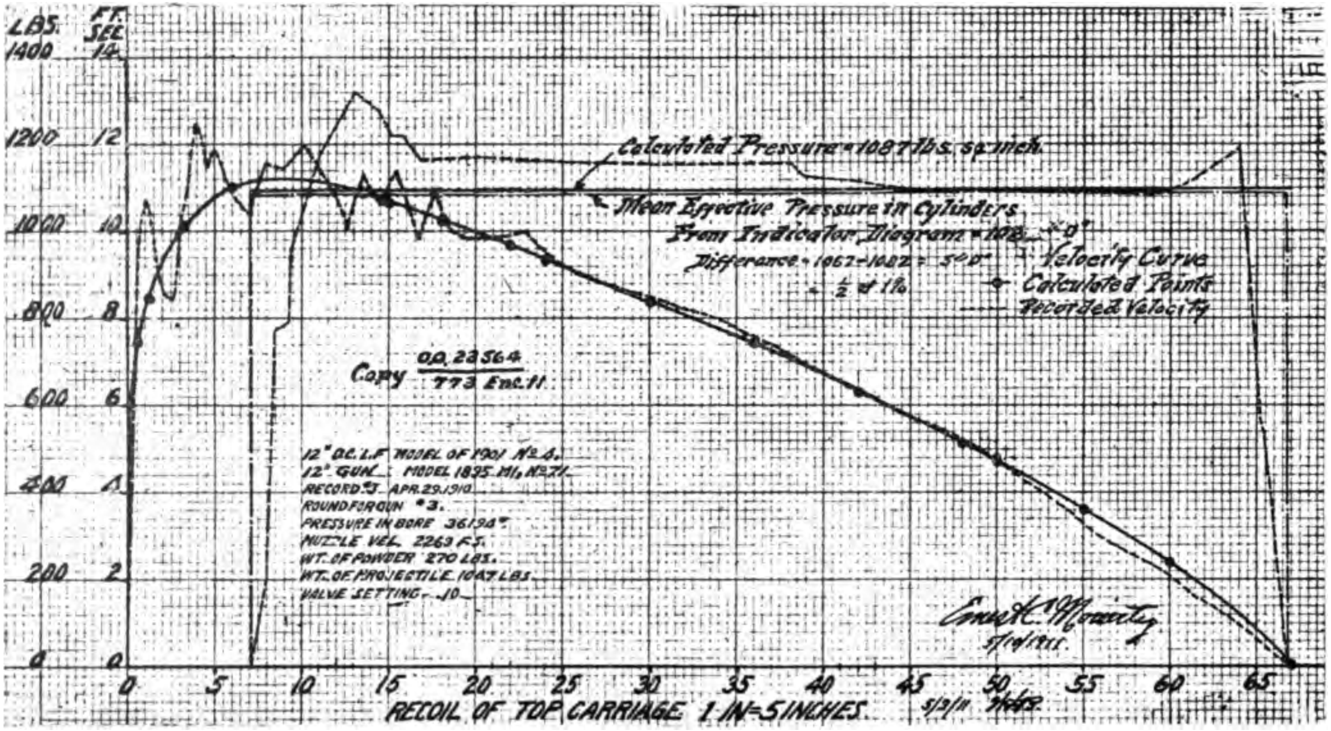
FIG. 8.

trol over the recoil is obtained. Within the last year this matter has been taken up, new throttling bars being designed for these carriages, and the constant clearances in the cylinders being diminished one half. In the experiments so far made with the new bars and reduced clearances, satisfactory results in the control of recoil have been obtained.

In order to determine whether the throttling bars are satisfactory, in addition to the observations taken on the length of recoil, it is customary to take pressure indicator records of the cylinder, and velocimeter records of the top carriage. With these data it is possible accurately to check back on the calculations and to determine the corrections necessary, in case the first results are not satisfactory. It has been found that very slight differences in the shape of the throttling bar orifice in the piston head, in the thickness of the piston head, in the pressure in the cylinder, and in the velocity of recoil, all affect the results obtained. Consequently, the results from the first calculations may not be satisfactory.

There are certain features of the disappearing carriage which are not apparent unless a special study of the design is made. A knowledge of some of them is especially valuable when considering the action of the carriage in target practice. One that has excited considerable comment, is what is commonly termed the "*kickdown*."

In the elevating mechanism of all disappearing carriages there is provided either a slip friction or a slide opposed by buffer springs. Under the action of the powder gases, if the gun were free to move, it would recoil in a straight line in prolongation of the axis of the bore. In order, however, to bring the gun to proper loading position and to cause it to disappear behind cover, the gun levers, rotating in the movable top carriage, and the elevating arm are provided. If the elevating arm were held rigid at its lower end instead of being provided with a "kickdown" mechanism, the tendency would be to start the gun in rotation in depression at the instant it started to recoil, which would result in a very high angular acceleration being given to the gun, thereby throwing very great stresses on the elevating arm, and, more important still, would cause the gun to change elevation before the projectile had left the muzzle. To overcome this, the "kickdown" mechanism is provided. The resistance in this mechanism to the motion of the gun is very small as compared


LBS.
FT. SEC.
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40
45
50
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60
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Calculated Pressure = 1087 lbs. sq. inch.
Mean Effective Pressure in Cylinders
From Indicator Diagram = 1082
Differance = 1067-1082 = 5 lbs.
= ½ of 1%
Velocity Curve
Calculated Points
Recorded Velocity
Copy O.O. 23564 / 773 Enc. 11
12" D.C. L.F. MODEL OF 1901 No. 4.
12" GUN MODEL 1895 M1, No. 71.
RECORD No. 3 APR. 29. 1910
ROUND FOR GUN #3.
PRESSURE IN BORE 36194#.
MUZZLE VEL. 2263 F.S.
WT. OF POWDER 270 LBS.
WT. OF PROJECTILE 1047 LBS.
VALVE SETTING .10
Ernest H. Moriarty
5/19/1911.
RECOIL OF TOP CARRIAGE 1 IN=5 INCHES.
5/3/11

FIG. 9.

1450

with the force required to start the gun in rotation about its trunnions. Consequently, as the gun starts to recoil, it continues to move along a line parallel to the axis of the bore until the spring of the "kickdown" mechanism is compressed solid or to the stop provided; or, in the case of the slip frictions, until the gun reaches the latter part of recoil. As a result, there is no appreciable change in elevation during the time the projectile is in the bore, and accuracy of fire is preserved.

There is another feature of the elevating mechanism which is interesting. It is, of course, especially desirable that the gun shall always recoil to the same height above the loading platform. To secure this, however, it is necessary that the elevating rack or slides for the elevating gear be curved, having a radius the length of the elevating arm. This construction presents mechanical difficulties, as was found in the earlier carriages. In the later carriages an elevating screw has been substituted for the elevating racks. The axis of this elevating screw is laid out as a chord of the arc described by the lower end of the elevating arm with the breech held fast in one position. Thus a minimum change in elevation in the height of the breech is obtained. Zero degree elevation is considered the normal position of loading, and the height of the breech at minus 5 degrees and plus 15 degrees elevation is the same. This gives, in the usual case, a variation in the height of the breech above the platform of from six to eight inches.

The arc described by the trunnions of the gun in recoil, is an ellipse, and it is this feature which has rendered the Buffington-Crozier carriage a success as compared with other designs of disappearing carriages. Other disappearing carriages have been manufactured abroad, but all of these have been built with a fixed gun-lever axle. This, increases the forces on the gun-lever axle, as it must take the entire powder pressure, which adds greatly to the bulk of the carriage. It also reduces the cover obtained from the parapet, as the crest must be lowered to clear the gun, which begins to drop as soon as the gun starts to recoil. These carriages have various methods of controlling the recoil. The recoil cylinder is usually linked to the gun-levers in some manner, and the counter-recoil accomplished by pneumatic pressure or counterweights. It is understood that Germany is now manufacturing a disappearing carriage of the same design as that used in our service.

In the design of the carriage for the 16-inch gun, which will ultimately be mounted in the fortifications of the Panama Canal, the question was considered as to whether this carriage should be of the disappearing or barbette type. After a thorough study of the question, and after giving due consideration to the difficulties of design, manufacture, and cost, a disappearing carriage was decided upon. As to cost, a disappearing carriage, for the same amount of protection, will cost only about one-half as much as a barbette carriage with armored protection. Of course, a large part of the cost of a barbette carriage is in the armor, so the cost can be very materially reduced if only thin armor be used.

The 16-inch carriage will be of very great size and will require power traversing and elevating. To give an idea of the size of this carriage, it may be stated that the height of the axis of the bore in battery above the level of the concrete on which the base-ring rests, will be approximately 27 feet. The length of the gun-levers, from the cross-head pin to the gun trunnions, is approximately 21 feet. The elevating arm is approximately 22 feet long. The weight of the 16-inch gun is 142 tons; the counterweight will weigh approximately 400,000 pounds; the total weight of the rotating parts of the carriage that must be traversed will be about 550 tons; the total weight of the carriage, including the gun, will be about 620 tons. It is anticipated that the cost of this carriage will not exceed $130,000. In providing for power elevating and traversing, it is intended to use hydraulic speed gears such as are used on naval turrets, which will give a uniform control of the speed from zero up to the maximum provided. The carriage will permit of 5 degress depression and 15 degrees elevation. The providing of higher elevations, that is, elevation from 10 degrees to 15 degrees in a disappearing carriage, adds very grealty to the strain on the carriage, due to the fact that the vertical component of the powder gases increases very rapidly as the elevation is increased. This must be carried by the upper end of the gun-levers, the top carriage, the live rollers, and so on, down to the foundation. One of the noteworthy circumstances of the construction of this carriage is the fact that, by making the counterweight of cast-iron instead of lead, it is possible to effect a saving in cost of $20,000, due to the difference between the prices of lead and cast-iron. These figures are only approximate, but they indicate the tremendous masses in the carriage.

As a matter of design, the 16-inch carriage is no more difficult than the 14-inch; perhaps not so difficult, as in the 14-inch design it was contemplated obtaining a carriage that could be mounted in the 12-inch emplacements without rebuilding. Also, the 14-inch wire-wound guns were especially light in proportion to the weight of the projectile, which very greatly increased the stresses on the carriage, due to the greater acceleration and greater velocity of free recoil. Consequently, the strains on the 14-inch carriage are much greater in proportion to the caliber of the gun than they will be in the 16-inch carriage, which uses a gun of the built-up type similar to the 12-inch of model of 1895. A wire-wound gun, however, has been designed which will weigh probably not more than 200,000 pounds.

It has been stated in certain articles which have appeared in newspapers from time to time, that the reason for the Army's advocating lower velocities for their guns was found in the fact that the higher velocity guns, such as those used in the Navy, could not be mounted on disappearing carriages. This, however, is not the case, for the maximum forces on the disappearing carriages are those due to the acceleration of the parts of the carriage while the powder gases are acting, and the accelerations are directly dependent upon the weights of recoiling parts and the maximum powder pressure. But the higher velocities require a longer gun, and no increase in the maximum pressure; and, since the longer gun increases the weight of the recoiling parts, if there is no increase in the powder pressure, the acceleration of the various parts of the carriage will be less. On the other hand, while it is true that with the longer gun required for the higher velocities, there is a slight increase in the difficulty of providing satisfactory cover for the disappearing carriage, yet the difficulty is not insurmountable.

In all disappearing carriages so far designed, the angle of cover provided by an emplacement approximates seven degrees. This angle is slightly less for emplacements which permit of depression. By this cover angle is meant the angle of fall of a projectile just clearing the top of the parapet and the breech of the gun. The angle of fall of all modern naval guns at usual battle ranges will be seven degrees or less. It is entirely probable that projectiles striking an emplacement will throw fragments of concrete into the carriage. There are, however, very few parts of a disappearing carriage which would be damaged to any great extent by fragments of projectiles or concrete. Sight standards, of course, might be hit; but the carriages would not necessarily be put out of action so long as they could be laid in azimuth. Spare sight standards and sights can be supplied in order that carriages may be put in repair in a reasonable time, in case the standards were, by chance, hit.

Mortar Carriages

The use of mortars dates back to the very earliest of seacoast fortifications. The early type of mortar carriages, however, were of the simplest construction, consisting merely of two cheek-pieces connected by transoms; and they were maneuvered by handspikes on a platform. Pointing was done by establishing the "line of metal" and locating it by means of aiming trestles in the general direction in which it was desired to fire the mortar. The first improvement on this carriage was proposed about 1870, when the center-pintle type of mortar carriage was recommended. This consisted simply of the old form of mortar carriage mounted on a chassis of the type used for the early barbette seacoast guns.

In connection with the development of the new armament in this country, authorized shortly after the report of the Endicott Board, the Ordnance Department took up the question of providing a more satisfactory mortar carriage; and in 1893 there was tested out the first spring-return, or Model of 1891, mortar carriage. This carriage is a combination of an English and Russian design. It, however, did not prove entirely satisfactory, as at low elevations—those between 45 degrees and 48 degrees—the carriage was not sufficiently strong. Before this carriage was issued to the service the weak parts had been strengthened. Only a small number of this type were manufactured, about 80 in all, and these are still in use, giving fairly good satisfaction, although the mortars mounted on them are of a lower power than those mounted on the Model of 1896-MI and MII carriages.

The model of 1896 and 1896-MI carriage was the invention of Lieut. W. B. Gordon, Ordnance Department, now professor of philosophy at the Military Academy.

For the weight of projectile and the velocities for which it was designed, the model of 1896 carriage was amply strong; but the demand for longer range, and the introduction of capped projectiles, so increased the work the carriage was required to do that various parts began to break. The racer was the first part to give serious trouble, and it was strengthened by the addition of steel I-beams, or side-frames, to carry the trunnions of the recoil cylinders. Breakages also occurred in the top-carriage, which was originally of cast-iron; so cast-steel was substituted. Even since the strengthening of the racer, there have occurred in a number of carriages cracks extending from the opening for the recoil cylinder on the right side of the carriage through the bolt holes for the traversing brake. This crack, although objectionable, does not cripple the carriage so far as firing is concerned, as carriages have been fired from 50 to 100 rounds after the crack developed, without any change in the ease with which the carriage could be traversed.

This crack's not interfering with the serviceability of the carriage is due to the fact that the crack is caused by tension in the racer, set up by the thrust of the top carriage forward while the powder gases are acting in the mortar; and, while this thrust must be transmitted to the pintle at the rear end of the carriage through the racer, so long as the racer is intact, yet as soon as the crack occurs in the racer, the stress in the racer is transferred from it to the side frames, which are amply strong for the purpose.

The model of 1896-MII carriage is a modified 1896 carriage, the racer being greatly strengthened in order to bear the greater loads imposed by the heavier projectiles and higher velocities.

For the Panama Canal there has been designed what is known as the Model of 1896-MIII carriage, which is a still stronger carriage of the general type of the 1896, or Gordon, carriage. The principal change in this carriage is that all parts are made of cast-steel and are of much more massive design. That this is a necessity is obvious, since the mortar which the carriage mounts fires a 700-pound projectile at a velocity of 1850 feet per second, making the power of this mortar but little less than that of the 10-inch gun. The range it is expected to obtain with this mortar is about 20,000 yards. Up to the present time the carriage has been fired from only about thirty times satisfactorily; and it has required nearly six months to fire that number of rounds, because, at the long ranges at which the mortar is fired, the fall of the shot can be seen only on the very clearest days.

The 12-inch mortar carriage, model of 1908, was designed for use in the insular possessions.

This carriage is, in theory, an advance over the 1896 type; in actual experience, however, there is little gain to offset the added complications. The carriage consists of the usual racer, base-ring, and traversing system. Chassis are provided on the racer. In trunnions in the chassis rests a cradle containing the recoil and spring cylinders. In guides in this cradle slides the sleigh containing the trunnion beds for the mortar trunnions. The mortar can be depressed independently of its cradle. This permits the mortar being depressed for loading while the cradle is set in elevation. In theory, this would give a slight increase in the rate of fire. It was found, however, almost a mechanical impossibility to design a sleigh and cradle strong enough to withstand the firing strains without making them so massive that the cradle could not be elevated with the required ease. The carriage has the advantage of having the recoil cylinders parallel to the axis of the bore at all elevations. This permits firing from the carriage at elevations from zero to 45 degrees, as well as from 45 degrees to 65 degrees. No carriage is mounted for firing under 45 degrees, however.

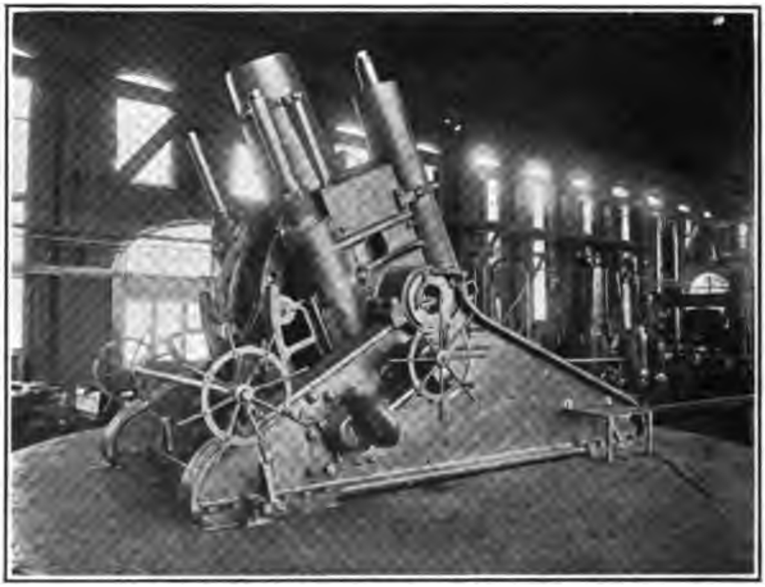

FIG. 10. 1451

12-inch mortar carriage, Model 1908.

RAPID FIRE CARRIAGES

The only new type of rapid fire carriage is the 6-inch barbette carriage, model of 1910, four of which will be mounted in Fort Drum, El Fraile Island, and two in Fort De Lesseps, Panama.

This carriage was primarily designed as a casemate mount, but by changing the shields has been adapted for use as an ordinary barbette carriage. As a casemate mount, owing to its compactness, it permits of 120 degrees traverse, which could not be obtained with the 6-inch barbette, model of 1900. The shield for this carriage is cast-steel, manufactured under the Hadfield process. About 5.3 inches of this armor is equivalent to 4.5 inches of face hardened Krupp armor. The cost of the cast-steel shields for four carriages was but little more than the Krupp armor for one.

Modifications of Old Carriages

The 15-pdr. balanced pillar carriages, model of 1898, are being converted to barbette carriages; that is, the balanced pillar feature is being removed. They are being provided with new traversing and elevating mechanisms, range discs, telescopic sights, and lighting circuits. They will also be provided with mechanical firing devices, in connection with modification of the breech-blocks to provide eccentric firing pins. It is believed that, so far as accuracy of fire is concerned, after the modifications are made, these carriages will be equal to the 15-pdr. carriages, model of 1903.

The 15-pdr. barbette carriages, model of 1902, are being provided with range discs which permit of the same system of firing with these carriages as with other rapid fire carriages. Some of the 15-pdr. barbette carriages, model of 1898 MI, and the 15-pdr. carriages, model of 1902, with range discs, should be in use for the next target practice.

Accessories

Difficulty has been experienced in the past with a haze in sight and range finder telescopes, due to accumulation of dust and moisture on lenses and prisms. For the past year or more, effort has been made to render all instruments as dust and moisture proof as possible. In some of the older instruments this cannot be completely accomplished; special attention, however, is paid thereto in new design. The 2-inch telescopic sights, model of 1909, being used on the 15-pdr. model of 1898 MI carriages, and the 3-inch telescopic sights, model of 1912, being used on the 6-inch Disappearing carriage, model of

1905 MII, and on the 14-inch Disappearing carriage, model of 1907 MI, are believed to be very efficient in this respect.

Electric Firing

At a conference held with the Chief of Coast Artillery, this past spring, an agreement was reached to supplant friction firing by electric. The Ordnance Department for many years past has favored some form of electric firing, and a system has been provided on a majority of the carriages for the larger caliber guns. This system has not been used generally, one reason therefor being the unsatisfactory source of current provided, and further, because the target practice orders have not provided for electric firing. This has resulted in the circuits not being cared for, and it will undoubtedly be some time before they will be in a satisfactory condition. Use in drill and practice will, however, show the faults, and necessary corrective measures can be taken. The new system agreed upon will consist of a hand operated A.C. magneto mounted on the sight standard, and connected by a two-wire circuit to a 1-to-1 transformer near the breech of the gun. The secondary of this transformer contains a simple electric primer. This system has been tried out with an experimental magneto with the present carriage wiring, with very satisfactory results. The system of electric firings outlined above was suggested by the Coast Artillery Board, and is believed to be more satisfactory than any other system yet devised.

Shot Trucks

For many years the question of tires for shot truck wheels has troubled both the Ordnance Department and the Coast Artillery Corps. After extensive experiments by private manufacturers and at Ordnance Department establishments, the conclusion has been reached that it is practically an impossibility to obtain a rubber tire that will not work loose from the wheel. This is due to the fact that with the small diameter of wheel which it is necessary to use on ammunition trucks, the pressure on the tire produces a creeping effect as the tire is compressed, which soon loosens it. In new design trucks, the lead of automobile makers has been followed, and detachable tires are provided. It is believed that not only will these tires have a longer life, but also can spare tires be kept on hand at posts and attached by any one when required. This will avoid the placing of shot trucks out of commission while wheels are being re-tired.

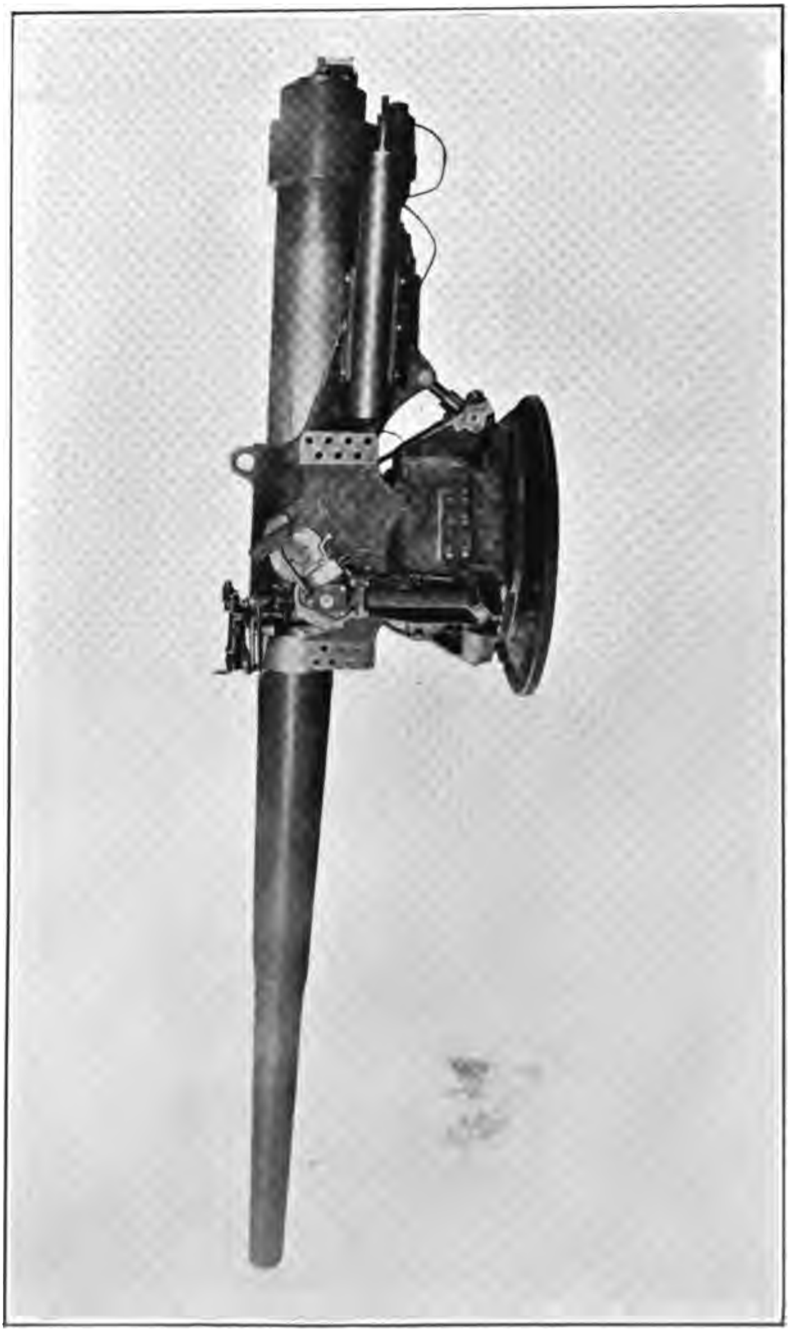

FIG. 11.
6-inch barbette carriage, Model 1910. (With shield removed.)

CARE OF ORDNANCE MATERIAL

The need on the part of every artillery officer for a thorough and intimate knowledge of the guns and carriages assigned to him has been evident from an observation of target practice records and armament reports for a number of years.

This knowledge can not be acquired by perfunctory inspections and a mere attendance at drills. Each part of a gun, carriage, or piece of fire control apparatus should be studied with a view to ascertaining its functions. They are fully described in the handbooks descriptive of guns, carriages, etc. The various mechanisms should be disassembled and put together, and working parts examined for lubrication, cutting, and wear. In short, an officer should so know his material that the slightest malfunction may be at once apparent to him. Such a study should be made especially of all safety features. It should not be necessary for an inspector to point out defects. These should be known to, and steps for their correction initiated by, the battery commanders.

A thorough study of and careful attention to the mechanical features of the material of his battery is not only interesting but profitable to a battery commander in the more satisfactory results obtained in target practice.

THE NEW COOKE-POLLEN RANGE-FINDER

By E. WILFRED TAYLOR

In the early part of 1911 and after nearly ten years experience with fire-control instruments, the Argo Co., Ltd.* began the design of a new range-finder with two distinct objectives in view:

(A) The greatest possible illumination.
(B) Invariability at all ordinary temperatures.

Hitherto the makers of self contained horizontal base range-finders have had three grave difficulties to contend with:

1. The internal tube carrying an object glass at each end has always been open to the objection that inconceivably small buckling under unequal or different temperatures may result in very serious errors in range readings.

2. The variability of the solid glass pentagonal prisms. The Argo Co. and certain German experimenters had found that these prisms do not usually reflect off the rays at the same angle at all temperatures, some exhibiting much more serious variations in this respect than others. This is quite apart from the temporary deformation of figure which takes place in them when in course of changing temperature. Moreover, the size in which these prisms can be successfully made is strictly limited.

3. The law of the prism travelling parallel to itself between the objective and its focus is

$$d = \frac{DC}{F}$$

d = shift of focus in circular measure, usually seconds of arc.

D = distance of prism from the focus, or primary image.
F = focal length of the objective.
C = deviation given by the prism in circular measure.

For instance, C may be 10 minutes when $D = F$, or when the prism is close up to the objective. Here the full angular deviation C is obtained at the focus, or $d = C = 10'$.

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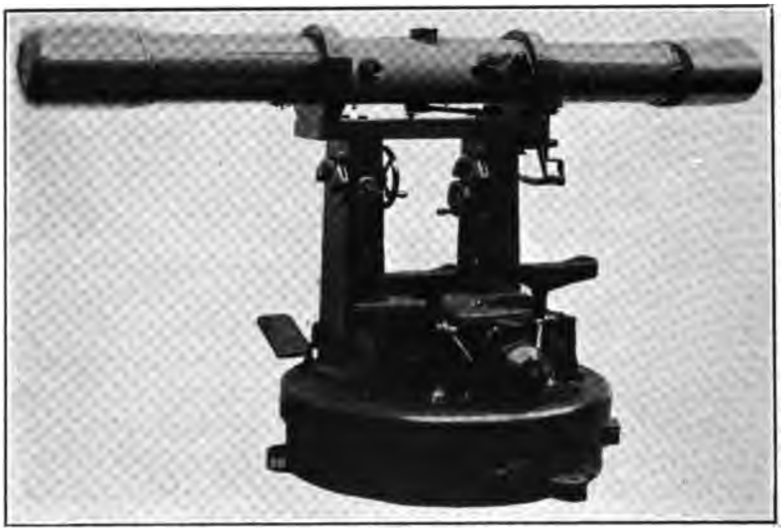
* Bishophill House, York, England.

$$\text{If } D = \frac{1}{10} \text{ of } F, \text{ then } d = \frac{C}{10} = 1'.$$

Since $\Delta d = \frac{C}{F} \Delta D$, a constant lateral movement of the prism wherever it occurs always yields the same shift of the image seen through it. But the shift, in seconds of arc, means an increment of range which varies as the square of the range, so that the least mechanical inaccuracy in the traverse of the prism may cause very serious errors at the long ranges. Consequently, the scale closes up rapidly as the long ranges are reached.



COOKE-POLLEN RANGE-FINDER 1453

In the Cooke-Pollen Range-Finder these three fundamental difficulties have been overcome in a novel manner that allows great accuracy of instrumental construction.

Its five characteristic features are:

1. *The total abolition of the double telescope looking opposite ways.*—Only one telescope is employed, the objective of which is of 3-7/8 inches aperture, the upper half receiving light from the distant object through the left hand window of the instrument, while the lower half receives light from the distant object through the right hand window of the instrument.

The area of each half of the object glass is 2½ times the effective area of the objective in use in the usual 9-ft. service range-finder; and this fact, together with the horizontal amplifying device and additional low power, as against the vertical amplifying system in use in the service instrument, gives a relative advantage in brightness of image of at least 8 to 1 for each eye alone in favor of the Cooke-Pollen instrument. If both eyes are employed, then the apparent luminosity is still further increased.

The horizontal magnification of the low power eye lenses is 24 diameters, and of the high power lenses 54 diameters; while the power in the vertical direction, wherein magnification is unnecessary and only wastes light, is half the above. Thus with the low power in use, the circular field of view appears drawn out into an oval.

It should be remarked that this great advantage of luminosity will not be observed so much in ordinary daylight; since the pupils of the eye are not then dilated enough to take in the extra light provided.

The extra magnification in the horizontal plane is brought about by the employment of two achromatic cylindrical lenses PA and NA which are shown in plan, Plate III. By this device magnification enough to show up conspicuously the defects in coincidence is obtained without the disadvantage of that loss of light which would inevitably follow, if the vertical magnification were made equal to the horizontal.

2. *The total abolition of the solid glass pentagonal prisms hitherto employed as optical squares.*—After many trials and experiments there has been devised a form of optical square, S_1 and S_2, which consists of two strictly parallel plane glass mirrors, silvered on their backs, mounted in a firm yet perfectly free manner in a metal frame of nickel-iron having the same rate of thermal expansion as the glass. These have the great advantage that they can be as easily manufactured in large sizes as in small. There is one, S_2, rather larger than the other in the right hand box a_2 of the instrument which is level with the lower half of the objective. This reflects the pencils of light received through the right hand window W_2 and the swinging range prism P_2, along the bottom of the internal tube, past and underneath the left hand optical square S_1 (which is mounted upside down with the lower edges of its two mirrors level with the center of the objective) and thence on to the lower halves of the three end mirrors M_1, M_2, and M_3, which reflect the pencils into the lower half of the telescope

objective O. Similarily the pencils of light received through the left-hand window W_1 and the zero setting prism P_1 (whichis an exact duplicate of the swinging range prism P_2) is reflected by the upside down left-hand optical square onto the upper halves of the above mentioned three mirrors, which thus reflect the pencils under precisely the same conditions as those from the right hand view, into the upper half of the telescope objective.

The reason why three reflections are here used instead of only two is to obviate the necessity for two reflections at the elbow of the telescope where the light is reflected at right angles into each eye. Apart from the optical squares, an even number of reflections must be used if the final view is not to be reversed left to right.

It has sometimes been objected that such silver behind glass mirrors must give false images reflected from their outer surfaces, but it can be shown that if they are truly parallel, as they can be made, and are employed solely for reflecting beams of practically parallel rays, then the images reflected from their outer surfaces will in the telescope exactly coincide with and reinforce the much more brilliant images reflected from their silvered surfaces. As a matter of fact, no duplicate and fainter images can be detected. The loss of light from one of these silvered mirrors 30 inches thick is very small indeed; for, in the first place, the light reflected from the first surface is not lost, as explained above; and, in the second place, it has been proved by experimenting with many successive reflections, that a well polished and well silvered glass surface reflects internally 98 per cent to 99 per cent of light, so that there is only the 1 to 2 per cent here to be added to 2 per cent lost by absorption through the glass (one inch of borosilicate crown glass absorbs only 3 per cent) leaving 96 to 97 per cent of light effectively reflected from each mirror.

It will be clearly seen that, since each one of the three end reflectors M_1, M_2, and M_3, is one solid reflector one half of which reflects the light from the right end of the instrument and the other half of the light from the left end, therefore the exact fixing or immovability of each of these mirrors is of no great moment; for, should one of them move, it is clear that both the upper and lower images in the same field of view will move together, so that coincidence will not be affected at all, unless the movement of the mirrors exceeds several minutes of arc, when very small errors may come in at the shortest ranges and at infinity and very long ranges, but no errors at all at the fighting ranges of 6000 to 10,000 yards.

It is only in the case of the two optical squares that any relative movements of the two constitutent mirrors would be fatal; and, as these constitute the most vital elements in the whole construction, great care has been taken to obviate all likelihood of variability in the angles enclosed between the two mirrors composing them. A reference to Figs. 14 and 14a, Plate II, will show how these mirrors are mounted and secured in such a way that they are firmly yet freely held without any perceptible strain ensuing. It will be seen (Fig. 14, Plate II) that three pivoted pallets *p*, operated by springs, hold the mirror against three opposite privoted fixed pallets. In order to obviate sliding friction of the metal pallets upon the mirrors, the metal employed for the frames has a coefficient of thermal expansion equal to that of the glass used for the mirrors. As a matter of fact, these frames might be of any other metal without any perceptible inaccuracy showing itself at different temperatures, provided the pallets embracing the mirrors can slide slightly but freely upon the glass surfaces and so allow for the metal expanding or contracting more than the mirrors. It is clear that under such circumstances the angle between the mirrors would not vary; but such friction under the allowed pressure of 5 lbs. on each pallet, if repeated over a long period, might endanger the first contact surfaces and rub them away. Moreover, owing to the frictional resistance, most probably the most natural accommodation between frame and mirrors would take place by jerks. To obviate this the alloy of nickel-iron is used for the frames. It is carefully annealed and its coefficient of expansion may be counted on not to differ perceptibly from that of the glass.

In actual practice the stability of these optical squares at all temperatures is such that usually no alteration or adjustment of the coincidence is required after it has once been correctly set.

3. *The adoption of a swinging prism for neutralizing the angle of parallax.*—It is claimed that this device allows a greater degree of instrumental accuracy for the long ranges than can be obtained by the use of the prism sliding parallel to itself (which latter we have investigated earlier in this paper).

The swinging prism in the 9-ft. base instrument is an achromatic prism giving a minimum deviation of about 17 minutes. When set for infinity or minimum deviation it is very nearly square to the line of sight. It is made to swing about an axis parallel to its refracting edge, or perpendicular to its plane of refraction, through an angle of about 42°, when its extra deviation is about 10′ 20″, or enough to neutralize the parallax subtended by a 9-ft. base at 100 yards.

The law of this swinging prism is $d = CA^2$, in which d = shift in seconds;

C is the extra deviation given by the prism when turned one minute from its minimum deviation position; and

A is the number of minutes swing from the above position.

For instance, in the case of the swinging prism of the 9-ft. base range-finder we have:

$A = 1$ minute $d = .000077$ seconds.
$A = 1$ degree $d = .28$ ”
$A = 2$ ” $d = 1.11$ ”
$A = 3$ ” $d = 2.50$ ”
$A = 4$ ” $d = 4.45$ ”
$A = 5$ ” $d = 6.95$ ”
$A = 6$ ” $d = 10.01$ ”
$A = 7$ ” $d = 13.63$ ”
$A = 8$ ” $d = 17.80$ ”
$A = 9$ ” $d = 22.53$ ”
$A = 10$ ” $d = 27.82$ ”
$A = 12$ ” $d = 40.10$ ”
$A = 15$ ” $d = 62.60$ ”
$A = 20$ ” $d = 115.90$ ”
$A = 25$ ” $d = 189.$ ”
$A = 30$ ” $d = 281.$ ”

The law, $d = CA^2$, holds good up to about 15° of swing, when an additional deviation increasing as a higher power of A begins to be perceptible. This commences at about 8000 yards range and increases up to 1000 yards.

Thus the law, $d = CA^2$, holds good for all the longer ranges; so that, differentiating, we have:

The variation on deviation $= \Delta d = C' \, 2A'$, where C' = .00077 seconds, or the extra deviation for the first minute of swing; and

A' = angle of swing in minutes.

Therefore, the longer the range, the greater the change of swing required to produce visible effect. At 32,000 yards twice as much swing is required to produce a 1-second shift of the image as at 8000 yards, so that the scale can be more open at the long ranges than in the case of the travelling prism, and we are less dependent upon absolute accuracy in the position of the prism at long ranges.

The following table gives the shift of the image in seconds for a 1-minute alteration of swing at different ranges, supposing coincidence to have been obtained.

Range	Shift per 1-minute
1000	.440
2000	.310
3000	.252
4000	.220
5000	.195
6000	.178
7000	.160
8000	.150
9000	.145
10000	.138
12000	.125
15000	.112
20000	.097
40000	.069
50000	.062

The lever which actuates the swinging prism is 7½ inches long and one minute's swing therefore represents a movement of .00217 inch at the end of the lever, a very perceptible amount.

It will be seen from this table that at 8000 yards range 6-2/3 minutes of movement are necessary to produce one second increment in deviation, implying an optical gearing down of 400 to 1.

Thus the device of the swinging prism lends itself to great accuracy of instrumental construction and operation.

The range scale is graduated every 25-yard interval and between the 1000 and 20,000 is equicrescent, this result being obtained by the use of a cam C, Plate III, which governs the swing of the ranging prism P_2.

4. *The ready accesibility of the whole of the optical system of the instrument for cleaning purposes.*—The caps at each end of the instrument, covering the mirrors and swinging prisms, are easily removed, rendering these elements accessible, while the optical elements carried inside the tube can be removed readily from the outside and after cleaning replaced without any fear of affecting the accuracy of the instrument.

It may here be mentioned that the platforms f_1 and f_2, Plate III, carrying the optical parts at each end of the instrument, are carried on platforms secured to an inner tube t_2. The only connections between the inner tube and the outer shell carrying the end caps are two pairs of pivots G. The inner tube is hereby rendered as free as possible from having transmitted to it any buckling or bending strains to which the outer tube may be subjected through strong sunshine on one side only. There is free air circulation between the inner and the outer shells.

It will be seen that any buckling transmitted to the inner tube to which the end platforms are fixed, taking place in the horizontal plane, cannot affect the coincidence, since the angles at the base of the range triangle are not thereby affected; for, although such buckling has the effect of causing the optical squares to rotate with respect to one another about their vertical axes, yet such rotation does not in the least degree affect the angle between the incident and reflected rays, which angle is always exactly double the angle between the two mirrors concerned.

Should buckling take place in a vertical plane, then a halving error ensues. This error can at once be rectified by turning the milled head U provided for this purpose, and cannot cause any error whatever in coincidence, once the optical squares have been correctly adjusted.

5. *The application of binocular vision as a supplementary but substantial aid to range-finding.*—The only serious obstacle to the binocular coincidence always superseding the usual cut as seen with one eye only, is the atmospheric turmoil of the images which generally exists, especially when the sun is shining. But towards and after sundown, when the light is so decreasing that the extra light given by large aperture plus binocular vision is of the utmost importance, the mutual oscillation of the images rapidly declines; so that it may be said, the worse the light the steadier the image; and under such circumstances the binocular method of taking coincidence will, after a little practice, be found to give at least as great consistency of readings as does the usual type of instrument, together with the full benefit of the higher degree of instrumental stability which characterizes the Cooke-Pollen Range-Finder.

The binocular construction depends simply on an arrangement of prisms at the elbow of the telescope.

In the first place, the two images, as formed by light from the left hand and right hand ends of the instrument respectively, are formed upon the first surface or on the level of the ridge of the separating prism, SP, lower figure Plate III, shown in vertical section in Fig. 10, Plate II. This prism is united optically with the achromatic first lens (called the *halving lens*) of the four-lens eye-piece system. The two acting together cause two overlapping images of the object glass to be formed about level with the middle of the left hand prism, Figs. 12 and 13, Plate II (r_1, Plate III). Figs. 11 and 12 are views of these overlapping images—pupillary images, as they are generally called. The left prism, Figs. 12 and 13, has a slot cut right through it just allowing to pass all the light constituting the two overlaping half images, *b* and *t*, of the objective, while the light constituting the uppermost and lowermost half images, B and T, is reflected by the left prism into the left achromatic erector lens E_1, Plate III, which projects an erected image of the object on the back surface of the left field lens e_1.

On the other hand, the light passed through the slot in the left prism passes on to the right hand prism r_2, Plate III, by which it is reflected into the right erector lens E_2, which projects an erected image of the object into the right field lens e_2, the image being formed about 1/8 inch behind the latter.

In Figs. 11 and 12 the uppermost half pupillary image, B, is an image of the lower half of the objective; that is, it is formed by light from the right hand window wherewith the objective forms an upside down image upon the lower half of the separating prism. (Fig. 10.) This constitutes really the upper half of the real object or field of view seen from the right end of the instrument, and is projected by the upper part of the left prism and erector lens into the upper half of the left field of view.

Similarly, the lowermost pupillary image T is an image of the upper half of the objective; that is, it is formed by light from the left hand window wherewith the objective forms an upside down image upon the upper half of the separating prism. This constitutes the lower half of the real object or field of view seen from the left end of the instrument, and is projected by the lower part of the left prism and erector lens into the lower half of the left field of view.

Of the two overlapping pupillary half images, in Figs. 11 and 12, one, *t*, is an image of the upper half of the objective formed by light from the left window which forms an upside down image upon the lower half of the separating prism. This constitutes really the upper half of the real object or field of view seen from the left end of the instrument and is projected by the right prism and erector lens into the upper half of the right field of view.

The other overlapping pupillary half image, *b*, in Figs. 11 and 12, is an image of the lower half of the objective formed by light from the right hand window which forms an upside down image upon the upper half of the separating prism. This constitutes really the lower half of the real object or field of view as seen from the right end of the instrument, and is projected by the right prism and erector lens into the lower half of the right field of view.

Thus the upper half of the right field and the lower half of the left field together constitute the whole image as seen from the left hand window, while the upper half of the left field and the lower half of the right field constitute the whole image as seen from the right hand window. Fig. 1, Plate I, shows this diagrammatically.

Therefore, if the instrument is set for infinity and then directed to a finitely near object, the right hand view *r* of the object in Fig. 1 must appear displaced towards the left of the left hand view of the object. That is, in the right hand field of view *r*, Fig. 1, the lower image is displaced to the left, while its continuation in the left hand upper view is also displaced to the left (see *l*, Fig. 1). Therefore, in the right field, the lower image appears displaced to the left; while, in the left field, the lower image appears displaced to the right. Consequently, if the eyes binocularly converge upon the lower images so as to merge them into one, as in C, Fig. 1, then the upper images simultaneously appear separated at equal distances at either side of the lower image. Or if the eyes are made to binocularly converge or diverge upon the lower images so as to merge them into one, as in C, Fig. 2, then the lower images simultaneously appear separated at equal distances on either side of the upper image. Thus, when coincidence is not obtained, it is impossible to see both upper and lower images single simultaneously, so as to appear as solid and continuous right across the halving line.

Makers of large range-finders employing pentagonal prisms have found it necessary to provide means for adjusting the instrument at any time without the aid of external objects. A pair of small pentagonal prisms are used and they admit parallel rays of light into the larger prisms. Ingenious devices are used to eliminate errors due to the variability of the smaller prisms.

Owing to the great stability of the optical parts in the C.-P. Range-Finder it is usually quite unnecessary to alter the coincidence, once it has been correctly set. As in other instruments, it could be set on a star or on the moon. A special adjuster which can be used at any time is also provided. Above the left eyepiece is a milled head and toothed wheel, and on the latter figures are engraved at approximately 1-second intervals. An alteration of one second will cause the following errors at the given ranges:

Range	Range error caused by instrumental error of 1-second
20000	± 648 yards.
15000	” 364 ”
10000	” 162 ”
9000	” 131 ”
8000	” 104 ”
7000	” 79 ”
6000	” 58 ”
5000	” 40.5 ”
4000	” 26 ”
3000	” 14.6 ”
2000	” 8 ”
1000	” 2 ”

It is not anticipated that occasion will arise for readjusting of the coincidences, but it is as well always to have at hand a ready means of testing and adjusting coincidence without having to depend upon the sighting of celestial objects, which are not always to be seen when wanted.

Therefore, there is supplied a zero or coincidence tester and two collimator lenses, C_1 and C_2, with each instrument (Fig. 16). This is simply a device for presenting to the view of the range-finder two vertical black marks at a distance apart equal to the base length. The front view of the zero tester is given in the top figure of Plate III, where L.M. is the left hand mark and R. M. is the right hand mark. This instrument is made of materials corresponding to the range-finder itself, a precaution necessary for securing equality of distance at all temperatures between the centers of the windows of the range-finder and the distance between the two sighting lines as shown in Fig. 16.

Two collimator lenses, C_1 and C_2, are provided in glass cells, each of which fits easily into the window openings of the range-finder. The purpose of these collimator lenses is to make it possible for the range-finder to focus upon the zero tester marks at the distance of 170 feet; that is, to render the rays diverging from each mark about parallel, as if coming from a mark at an infinite or very great distance.

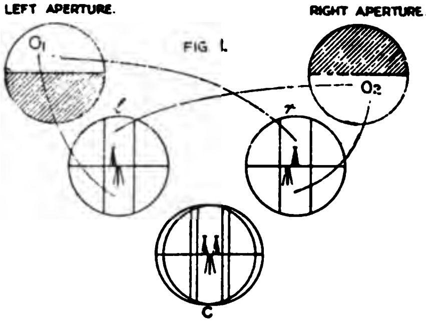
The range-finder should first be adjusted against halving error on some fairly distant object; and then, after having the collimators placed in position, the range drum must be set to the infinity mark and the instrument directed to look downwards to the distant zero marks.

The zero tester has screwed in its center a little sighting telescope. This is directed so that a circular white mark painted on the center of the range-finder is seen in the center of the field. Fig. 19 shows the view which should be seen through the sighting tube where the white spot is seen in the center of the little circle, while the horizontal line is set about parallel to the range-finder cutting through the center of its windows. So long as the sighting tube centers strike the range-finder within 10 inches left or right of the white spot the pointing is sufficiently accurate.

In the meanwhile, the observer at the range-finder is supposed to have directed the instrument so that the left window faces the left end of the zero tester, while the right window faces the right end. What he should see in the field of view of the right eye is shown in Fig. 15. The upper mark must be kept in the middle of the field, and for this purpose it is preferable to use the right eye only. Should there be any want of parallelism in the vertical plane between zero tester and range-finder, then the diagonal marks in upper and lower fields will not intersect in a common point in the halving line. He should then signal to the man at the zero tester to raise or lower one end of the latter until the diagonal lines about intersect to form a St. Andrew's Cross with the center blank, as in Fig. 15. This zero tester may be permanently fixed up at the correct distance from the range-finder mounting, when it will only be necessary to direct the instrument thereon.

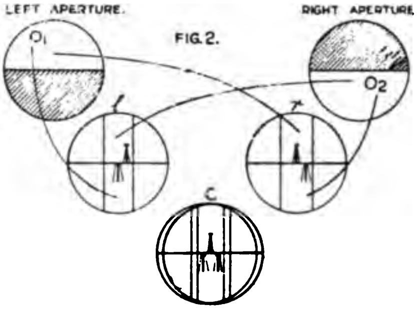
Any discrepancy between the vertical lines as seen in the top and bottom fields is corrected by the aforesaid coincidence wheel.

FIG 1.



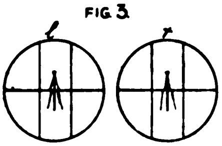
SHOWING ORIGIN & DISTRIBUTION OF THE IMAGES.
INSTRUMENTAL READING
LONGER THAN REAL RANGE.

FIG. 2.



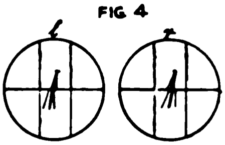
INSTRUMENTAL READING
SHORTER THAN REAL RANGE.

FIG 3.



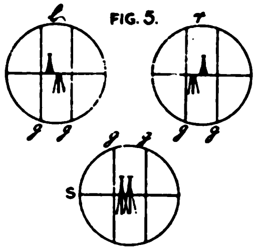
HALVING ERROR OF
EXCESS. DEFICIENCY.

FIG 4.

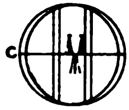


HALVING CORRECT, BUT
COINCIDENCE WRONG.

FIG. 5.

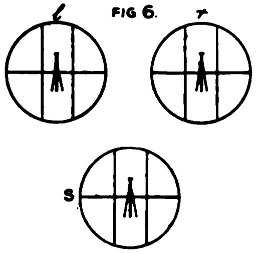


A POSSIBLE EFFECT OF A SQUINT
WHEN THERE IS NO COINCIDENCE.

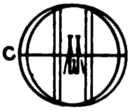


BUT ON BRINGING LOWER IMAGES
INTO ONE BINOCULARLY, THE
OTHER TWO SEPARATE MORE.

FIG 6.



PERFECT COINCIDENCE.



EFFECT OF A SQUINT WHEN
THERE IS PERFECT COINCIDENCE
ON BRINGING LOWER IMAGES
INTO ONE BINOCULARLY, THE
OTHER TWO ALSO COALESCE
INTO ONE.

PLATE I.

All adjustments are made from the outside of the tube, and the positions of the various knurled heads may be seen on reference to the sectional plan.

The illustration shows a 9-foot Cooke-Pollen Range-Finder on one of the Argo Co's* two-observer naval mountings.

The observer on the left traverses the mounting by hand or by power; in the latter case, by means of an adjustable speed power device, he can set the speed at which the hand wheel revolves so that the moving target is kept in the field of the finder through which he observes.

The range taker on the right hand elevates with the left hand, and with the right either ranges by hand or power. In the latter case, by means of an adjustable speed power device he can set the speed at which the hand wheel revolves.

Range-Azimuth Transmitters are attached to the stationary base, and multi-core cables connect them to synchronous numerical indicators.

A simpler form of this mounting is recommended for coast defense purposes.

Index of Range-Finder Parts (Plate III)

A	Knurled head for coincidence adjustment.
a_1, a_2	Oval covers, outer and inner, clamped up to flanges on outer tube.
t_1, t_2	Outer and inner tubes. The inner being supported only by two pairs of pivots G. Space between open to ventilation.
f_1, f_2	Platforms fixed to ends of inner tube and carrying mirrors, objective, prisms, cam, etc.
G	Two sets of pivots set in a horizontal plane. On these the inner tube freely rides.
T	The two flanges which rest on friction rollers carried by the mounting.
W_1, W_2	Plane parallel glass windows.
P_1	The zero setting prism. Operated by knurled head A through rod R_1.
P_2	The swinging prism, by operating which coincidence is obtained at each range.
C	The cam operating the range prism P_2.
L	The roller arm attached to P_2. The roller is in contact with the edge of the cam C.
x	The worm wheel governing the rotation of the

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* Bishophill House, York, England.

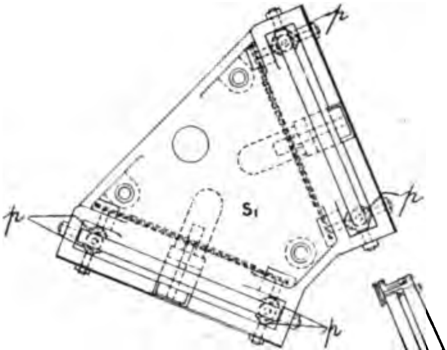

FIG 14.

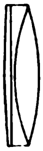

FIG. 10

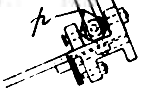

FIG 14 a

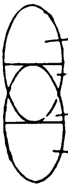

FIG. 11.

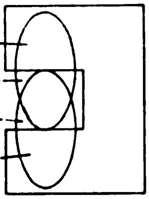

FIG. 12.

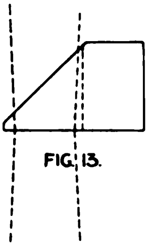

FIG. 13.

FIG. 17.

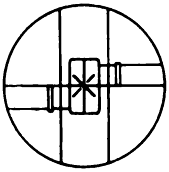

FIG 15

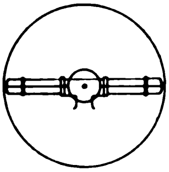

FIG 19

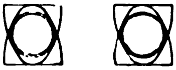

FIG 18.

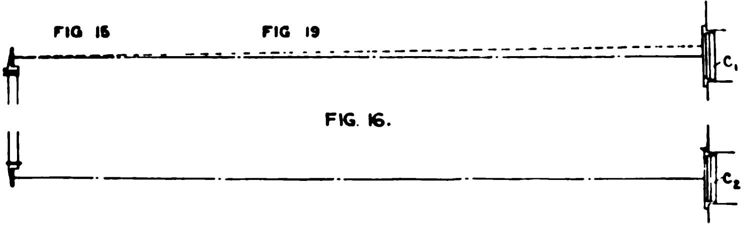

FIG. 16.

Plate II.

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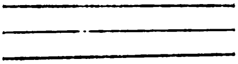
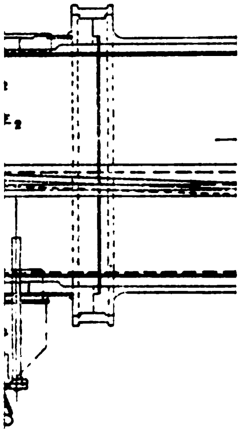
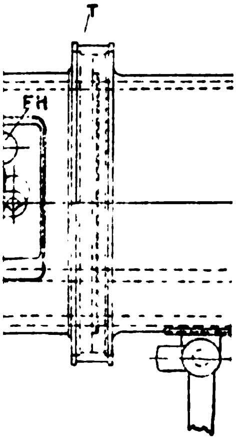
	cam. Rotation is transmitted from a handle on the mounting.
S_1	The left hand optical square of two immovable plane glass mirrors in a nickel-iron frame.
S_2	The right hand optical square. This is capable of a slight tilt for adjusting halving.
U	The knurled head for adjusting halving.
M_1, M_2, M_3	Three circular parallel glass silvered mirrors. These reflect the light received from both optical squares into the objective OG.
OG	The achromatic objective 3-7/8-inch aperture and 53-inch focal length.
r_1, r_2	Two prisms reflecting the light into the left and right eyes respectively.
FP	Two doubly reflecting prisms turning the light into the finder eyepiece.
RD	Glass protected aperture where the range drum is read.
DC	Chloride of calcium drying cage to prevent the bedewing of the optical surfaces.
HR	Auxiliary knurled head for controlling coincidence.
d	Milled head for adjusting width of halving line in left eyepiece.
SP	Separating or halving lens.
E_1, E_2	Left and right erector lenses.
FH	Special focussing head.
e_1, e_2	The two eyepieces.
FM	Finder mirror.
FO	Finder objective.
FE	Finder eyepiece.
B	The astigmatizer lens.
D	Knurled head operating the latter.
LM and RM	The two ends of the zero tester.
PA	Positive amplifying cylindrical lens.
NA	Negative amplifying cylindrical lens.
F	Focussing screw.




E_2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COMPARISON OF SIMULATED CONTACT AND OBSERVATION FIRING FOR MINE PRACTICE

BY CAPTAIN CHARLES R. ALLEY, COAST ARTILLERY CORPS

In this discussion it is assumed that the reader is familiar with the rules governing Mine Practice, contained in the Regulations for the Instruction and Target Practice of Coast Artillery Troops.

The drawing below shows the limiting positions which the target may have: Fig. 1, for a score of 25 or 15 in simulated contact firing, when the track of the target passes the mine at a distance of x feet; Fig. 2, for a score of 25 or 10 in observation firing, when the track of the target makes an angle of $\theta°$ with the line joining the nearest two mines. In Fig. 2, the track of the target is shown as passing directly over the mine, but it makes no difference where it passes, as the position of the target with respect to the zones is all that counts in this case, provided the nearest mine is fired.

Fig. 1.

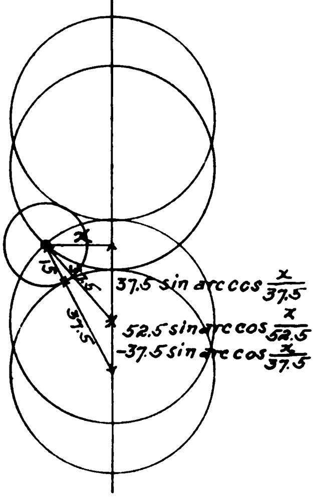
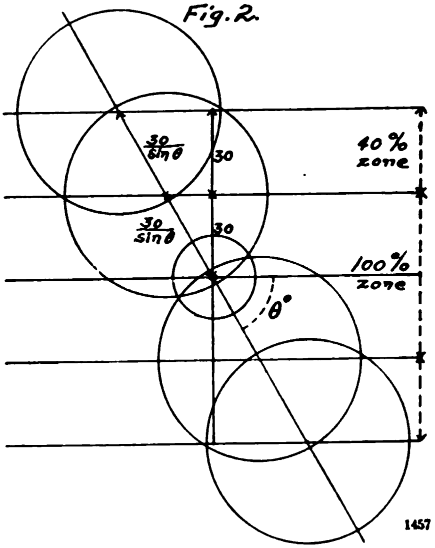

x
15
37.5
37.5 sin arc cos $\frac{x}{37.5}$
52.5 sin arc cos $\frac{x}{52.5}$
-37.5 sin arc cos $\frac{x}{37.5}$

Fig. 2.



From the drawing may be seen that in observation firing, when the track of the target makes $\theta°$ with the line joining the nearest two mines, 25 will be scored if the explosion occurs while the center of the target is moving $\frac{30}{\sin\theta}$ feet on either side of the center line of the 100% zone, and 10 if it occurs while the center is moving $\frac{30}{\sin\theta}$ feet on either side of the 100% zone.

Observation Firing.
$\theta°$ = angle between track of target and line joining nearest two mines.
25 score. Target travels in 100% zone $\frac{60}{\sin\theta}$ feet
10 score. Target travels in each 40% zone $\frac{30}{\sin\theta}$ feet

Simulated Contact Firing.
x = number of feet from mine to track of target.
25 score. Target travels 75 sin arc cos $\frac{x}{37.5}$ feet
10 score. Target travels on each side
$\left(52.5 \sin \text{arc} \cos \frac{x}{52.5} - 37.5 \sin \text{arc} \cos \frac{x}{37.5} \text{ feet}\right)$

log 30=1.47712 log 37.5=1.57403 log 52.5=1.72016 colog 37.5=8.42597 colog 52.5=8.27984

θ	log sin θ	colog sin θ	log 10 score distance	25 score distance	10 score distance
90				60	30
85	9.99834	.00166	1.47878	60.23	30.12
80	9.99335	.00665	1.48377	60.92	30.46
75	9.98494	.01506	1.49218	62.12	31.06
70	9.97298	.02702	1.50414	63.85	31.93
65	9.95727	.04273	1.51985	66.20	33.10
60	9.93753	.06247	1.53959	69.28	34.64

x	log x	log $\frac{x}{37.5}$	log sin arc cos $\frac{x}{37.5}$	log ½ 25 score distance	25 score distance	log $\frac{x}{52.2}$	log sin arc cos $\frac{x}{52.5}$	log subterm	subterm	15 score distance
0					75					15
5	.69897	9.12494	9.99610	1.57013	74.32	8.97881	9.99802	1.71818	52.26	15.10
10	1.00000	9.42597	9.98398	1.55801	72.28	9.27984	9.99198	1.71214	51.54	15.40
15	1.17609	9.60206	9.96214	1.53617	68.74	9.45593	9.98151	1.70167	50.31	15.94
20	1.30103	9.72700	9.92732	1.50135	63.44	9.58087	9.96595	1.68611	48.54	16.82
25	1.39794	9.82391	9.87240	1.44643	55.90	9.67778	9.94414	1.66430	46.16	18.21
30	1.47712	9.90309	9.77816	1.35219	45.00	9.75696	9.91416	1.63522	43.17	20.67
35	1.54407	9.97004	9.55505	1.12908	26.92	9.82391	9.87235	1.59251	39.13	25.67
37.5	1.57403				0	9.85387	9.84501	1.56517	36.74	36.74

In simulated contact firing, when the track of the target passes x feet from the mine, 25 will be scored if explosion occurs while the center of the target is moving 37.5 sin arc cos $\frac{x}{37.5}$ feet on either side of a perpendicular dropped from the mine to the track of target, and 15 if it occurs while center is moving a distance of $\left(52.5 \sin \operatorname{arc} \cos \frac{x}{52.5} - 37.5 \sin \operatorname{arc} \cos \frac{x}{37.5}\right)$ feet on either side of the limits of the above distance.

The preceding table shows for different values of θ and x, the distances traveled by the target while a score of 25, 15 or 10 is possible.

From the table it is seen that unless the target passes 35 feet from the mine, the distance within which a score of 10 is possible in observation firing, is so much greater than that in which 15 is possible in simulated contact firing, that the additional 5 in the score is outweighed by the greater probability of the occurrence of the explosion within that distance, especially as the 25 score distance in simulated contact firing reduces to zero at $x=37.5$ feet. Also, unless the target passes within 20 feet of the mine, at an unfavorable angle, observation firing gives a much greater probability of making 25, and under these conditions, failing the maximum score, the chance for making the minimum score is reduced nearly ½ in simulated contact firing.

Unless the target passes within 15 or 20 feet of the mine, observation firing will probably give the better figure of merit, and while this is not the prime consideration in any kind of target practice, there seems to be no particular value to simulated contact firing as training for simular work under service conditions, and the intention of the regulations appears to be for the use of the method which will give the better figure of merit.

With plotting boards the scale of which is 150 yards to the inch, it would be impossible to determine whether the target would pass within 20 feet of the mine, even if its course were plotting regularly and all conditions were of the best.

CONVERSION TABLE

MINUTES AND SECONDS OF ARC TO THOUSANDTHS OF A DEGREE, AND VICE VERSA

By LEWIS J. SCHROEDER, Ordnance Office, War Department

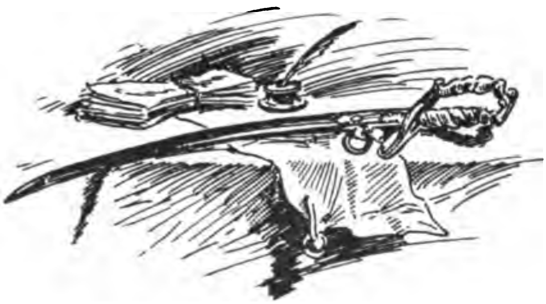
The three horizontal lines of numbers included between heavy rules are minutes of arc.

The numbers in the right hand vertical column are seconds of arc.

All other numbers in the table are thousandths of a degree.

For any number of thousandths of a degree, the equivalent in minutes and seconds is obtained by finding in the table the number of thousandths, and then following the vertical column up to the first horizontal line of minutes and the horizontal line across to the right hand vertical column of seconds; for example, 543 thousandths of a degree equals 32 minutes and 34.8 seconds.

For any number of minutes and seconds, the equivalent in thousandths is found at the intersection of the vertical column in which the minutes appear and the horizontal line in which the seconds appear.



CONVERSION TABLE

MINUTES AND SECONDS OF ARC TO THOUSANDTHS OF A DEGREE, AND VICE VERSA

Journal U. S. Artillery, May-June, 1914. To face page 314.

min.	0	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	sec.
	1	51	101	151	201	251	301	351	401	451	501	551	601	651	701	751	801	851	901	951	*3.6*
	2	52	102	152	202	252	302	352	402	452	502	552	602	652	702	752	802	852	902	952	*7.2*
	3	53	103	153	203	253	303	353	403	453	503	553	603	653	703	753	803	853	903	953	*10.8*
	4	54	104	154	204	254	304	354	404	454	504	554	604	654	704	754	804	854	904	954	*14.4*
	5	55	105	155	205	255	305	355	405	455	505	555	605	655	705	755	805	855	905	955	*18.0*
	40	90	140	190	240	290	340	390	440	490	540	590									
	41	91	141	191	241	291	341	391	441	491	541	591	641	691	741	791	841	891	941	991	*27.6*
	42	92	142	192	242	292	342	392	442	492	542	592	642	692	742	792	842	892	942	992	*31.2*
	43	93	143	193	243	293	343	393	443	493	543	593	643	693	743	793	843	893	943	993	*34.8*
	44	94	144	194	244	294	344	394	444	494	544	594	644	694	744	794	844	894	944	994	*38.4*
	45	95	145	195	245	295	345	395	445	495	545	595	645	695	745	795	845	895	945	995	*42.0*
	46	96	146	196	246	296	346	396	446	496	546	596	646	696	746	796	846	896	946	996	*45.6*
	47	97	147	197	247	297	347	397	447	497	547	597	647	697	747	797	847	897	947	997	*49.2*
	48	98	148	198	248	298	348	398	448	498	548	598	648	698	748	798	848	898	948	998	*52.8*
	49	99	149	199	249	299	349	399	449	499	549	599	649	699	749	799	849	899	949	999	*56.4*
	50	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900	950	1000	*60.0*

PLASTIC PAPER PULP FOR LAND FEATURES OF THE WAR GAME

[The JOURNAL is indebted to Captains W. F. Hase and W. H. Monroe, Coast Artillery Corps, for the following formula for land features for the coast artillery war game, prepared by Master Gunners Edward E. McCartney and Adam Ensch, Coast Artillery Corps, in the Coast Defenses of San Francisco.]

FORMULA

Tear old newspapers into small pieces; soak in water until thoroughly wet. (Clean ash-cans are convenient for use as mixing troughs.)

Reduce to a pulp by churning with a paddle.

After the paper has been thoroughly pulped, remove the free water and add one part of Portland cement to ten parts of the paper pulp.

Mix thoroughly, and squeeze out excess water.

MOLDING

The shore line and contours are laid out on the war game board and wire nails are driven in to the right distances to mark contours and prominent points. (The nails serve also to hold the paper pulp, when dried, firmly to the war game board.)

The land features are molded by hand, the mixture being worked in an ordinary dish-pan.

As there is a slight shrinkage when the pulp dries, in applying the pulp the nails should be covered by it from an eighth to a quarter of an inch.

The newspaper pulp is easily worked, and dries out in a few days; but to prevent warping of the board, the sections should be screwed to the trestles, holes for the entrance of a screw driver being left in the pulp, in order that the board may be taken apart for storage.

In addition to being easily worked, newspaper pulp is light in weight and trifling in cost and gives the land features a very realistic appearance.

Fogs and Smoke Screens

Fog screens are provided to represent the peculiar conditions that obtain in San Francisco harbor, where, in addition to the ordinary fog, there sometimes occur high fogs that prevent vision from batteries on heights, while not interfering with vision from lower lying batteries; and, at other times, low fogs that conceal all but the tops of the fire control masts of ships.

A very good representation of a low fog is afforded by sticks covered with fluffy white cotton and placed in front of the several ships. To represent other fogs, use is made of numerous folds of mosquito netting suspended from a light frame, the netting being attached at the bottom to a rod which is laid across nails driven into the frame and capable of being raised or lowered as desired. When all the folds are down, a dense fog is represented; and when all are raised, a high fog is represented.

A smoke screen is made in imitation of a dense cloud of smoke to screen the approach of destroyers and battleships.

COAST DEFENSE IN THE CIVIL WAR*

OPERATIONS IN MOBILE BAY

By 1st Lieut. WALTER J. BUTTGENBACH, Coast Artillery Corps

General Situation

After the surrender of the lower forts on the Mississippi River, resulting in the subsequent surrender of New Orleans, Admiral Farragut asked the Navy Department to be allowed to move against Mobile and close its harbor to the Confederates. The Federal Government, however, was far more anxious to gain control of the Mississippi River, so ordered Farragut to go up that river and combine with the fleet then under Admiral Foote, which, as we have seen in the previous paper, *Operations on the Mississippi River*, was done, but, due to lack of cooperation on the part of the Army, left no lasting results. The Mississippi River was not under Federal control till after the fall of Vicksburg and Port Hudson, July, 1863.

In the meantime, the Confederates at Mobile were left free, except, perhaps, when some blockade runner fell into the hands of the blockading fleet. And as the Confederates kept on strengthening their batteries and building up an ironclad force, delay simply meant, of course, that an ever increasingly formidable force would be required when the Federals should finally move against Mobile. But when the ironclads of the Federals were ready to attack, they were diverted for a time for use at Charleston harbor; so the attack on Mobile, which had been in contemplation since 1862, did not assume definite shape till the middle of 1864.

Had operations been undertaken promptly, as Admiral Farragut desired, the entrance into the bay would have been effected with much less cost in men and material, and Mobile would undoubtedly have fallen a year earlier than it did; and, as a result, the disaster of the Red River Expedition of 1864 might have been averted.

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* See note to "Coast Defense in the Civil War, Fort Sumter, S. C. (First Attack)," in Journal U. S. Artillery, for March-April, 1912.

Special Situation

In 1864 Mobile was a most important point for the Confederacy; in fact, it was the only important harbor left to it on the Gulf of Mexico, now that New Orleans had been lost.

Due to military operations elsewhere, especially the Red River Expedition, no Federal troops were available to cooperate with the Navy, until the latter part of 1864; and as Atlanta had by this time been taken and the march to Savannah decided upon, the movement against Mobile was, as has been well said by Commander Rodgers of the Navy in his *Study of Attacks upon Fortified Harbors* (Artillery Notes No. 28), not a step in a series of operations, but only an isolated operation, but none the less of great importance, having in view, as it did, the stopping of blockade running from that port and the breaking up of the ironclad fleet which was being built there and of which so much was expected.

Opposing Forces

CONFEDERATE

Mobile lies at the head of a bay that is twenty-four miles long and, in its upper part, ten miles wide, expanding to twenty miles at its southern end. The upper anchorage has only twelve feet, and the lower eighteen to twenty feet of water, the latter being five miles north of Mobile Point, or the main entrance to the bay. The entrance lies between two narrow sand spits and is approached by a channel running north and south. This channel is five miles long and only half a mile wide at its narrowest point, and has at its southern extremity a bar over which there is a depth of nearly twenty-one feet. The northern end of the channel of approach, and the entrance to the bay, was protected by two forts—Forts Morgan and Gaines. There was also a channel to the westward, north of Dauphine* Island, on which was Fort Gaines, running from Mississippi Sound into Mobile Bay; there Fort Powell was located. Still another channel was to the northwest. These channels had but little water and were comparatively unimportant, though of some use to the lighter blockade runners.

Fort Morgan, an old fashioned, pentagonal, brick work, mounting its guns in three tiers, was the principal defense of the bay, for the main ship channel passed close under its guns.

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* The spelling adopted in the text differs from that in the illustration used, but is in accord with present usage.—*Editor.*

It was situated on Mobile Point, on the right-hand side of the channel, entering the harbor. Its scarp brick wall was four feet eight inches thick, and its entire front was protected by an enormous pile of sand bags. This work was built on the site of an old work of the War of 1812, and at the time in question had the following armament:*

7 10-inch smooth bore guns
22 32-pdr., S.B. guns
2 6.5-inch rifled guns
3 8-inch smooth bore guns
2 8-inch rifled guns
4 5.82-inch rifled guns.

The exterior batteries (Batteries Gee and Bragg) had the following:

4 10-inch columbiads
1 8-inch rifled gun
2 32-pdrs., rifled.

In the fort sixteen guns bore upon the land approaches, counting those on the retired flank at the light house. There were no guns in embrasures, and no parados, as the width of the terreplein did not permit. The guns were pretty well protected by traverses against fire from the water, but not from land.

Within the fort was a citadel, loop-holed for musketry, having brick walls some four inches thick.

The fort was commanded by Brigadier General Page and had a garrison of 640 men.

Fort Gaines, a brick fort on Dauphine Island, was on the left of the channel, built on the ruins of old Fort Tombigbee, and its armament consisted of:

3 10-inch columbiads
4 32-pdr. rifled guns
and some 20 smooth bores, 32-, 24-, and 18-pdrs.

Of these guns some eleven bore on land.

This work was commanded by Colonel Anderson, who had 864 men.

Fort Powell, a minor work, had:

1 10-inch columbiad
1 8-inch columbiad
4 rifled guns,

The rear of this work was unfinished and all of its guns bore on the sound and the channel. Its garrison consisted of about one hundred men, there being two companies and a light battery.

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* Different authorities give slightly different data; see *The Gulf and Inland Waters*, Mahan, page 253.

Besides the three forts there were other elements of defense. From fort Gaines there ran out to the edge of the channel, a line of obstructions consisting of a double line of piles, the heads of which were just visible at low water, preventing even light draught vessels from entering the bay. From the end of the piling a triple line of fixed mines closed the main channel, nearly up to Fort Morgan, leaving clear a narrow passage close to the fort, for blockade runners. This passage was not much over one hundred yards from the beach.

The deep-water end of the line of mines was marked by a red buoy, and was 226 yards from the water battery of Fort Morgan.

Of these mines, 46 consisted of lager-beer kegs, filled with powder, fitted with wooden cones on the ends to keep them from tumbling over, and armed with four or five sensitive primers fastened to the upper side, to be exploded on a vessel's striking them. One hundred and thirty four mines were made of tin in the form of truncated cones, having the upper diameter the greater and divided into two parts, the upper part being an air chamber and the lower part containing the powder charge. They were all anchored with old grate bars, and were arranged to be exploded by passing vessels' knocking off cast-iron caps, which actuated triggers.

These mines were all of the floating type, and were about seven feet below the water. There were also said to be electrical mines, called submarine mortar batteries. Three of these were in the channel, having a charge of some 1500 pounds of powder and being about thirty to thirty-five feet below the surface.

Inside the harbor, under cover of the forts, were three wooden gunboats and the iron ram *Tennessee*, one of the most formidable ships the Confederates had ever built.

The gunboats, unarmored, except around engines and boilers, were the following:

1. The sidewheel steamer *Morgan*,
   2 7-inch rifled guns
   4 32-pdrs.
2. The sidewheel steamer *Gaines*,
   1 8-inch gun
   5 32-pdrs.

3. The *Selma*, an open deck steamer,
1 6-inch S. B. shell gun
2 9-inch S. B. shell guns
1 8-inch S. B. shell gun.

This vessel was a heavily built steamer, but the two first mentioned were wholly unsuited for war purposes.

The ram *Tennessee* was of the *Merrimac* type, but further improved. She was 209 feet over all and 48 feet on the beam, and drew 13 feet. Her casemate stood 8 feet above the deck, was amidships, and sloped at an angle of 33 degrees; it was armored with 5-inch iron plating on the sides and 6-inch at the forward end. The armament consisted of two 7-inch Brooke rifles, one in the bow and one in the stern, and two 6.4-inch rifled guns on each broadside. Her greatest defect was low speed and exposed steering gear, the speed being only six knots, and the steering gear being outside the casemate. The crew consisted of 18 officers and 110 men.

FEDERAL

The Federal fleet, under command of Admiral Farragut, consisted of vessels of various classes. There were the following:

Monitors	
Tecumseh	2 15-inch guns
Manhattan	2 15-inch guns
Winnebago	4 11-inch guns
Chickasaw	4 11-inch guns
Screw Sloops	
Hartford	21 guns
Brooklyn	24 guns
Richmond	20 guns
Lackawanna	8 guns
Monongahela	8 guns
Ossipee	11 guns
Oneida	9 guns
Seminole	8 guns
Double Enders	
Octorara	6 guns
Metacomet	6 guns
Port Royal	6 guns
Screw Steamer	
Galena	10 guns

Gunboats

Kennebec	5 guns
Itasca	5 guns.

Other smaller vessels were off the harbor entrance on blockade duty, but had little part in the engagement.

The land forces, under immediate command of Major-General Granger, consisted of a mixed force of infantry and artillery with a small amount of cavalry, the effective strength being about 5500 men. Of this force some 1500 took part in the siege of Fort Gaines and some 2000 later took part in the attack on Fort Morgan; but the rest were diverted to other purposes and subsequently detached, which, as we shall see, materially changed the plan of operations adopted.

Narrative of Events

In the early years of the Confederacy, Mobile Bay was the scene of nothing more than attempts at blockade running, which in some cases resulted in minor engagements between the runners and the blockading vessels. But after the surrender of New Orleans, the Confederates expected Mobile to be the next point of attack; so they made strenuous preparations for it, building, in the early part of 1863, five gunboats, and, in the winter of 1863-64, the ram *Tennessee*.

In January, 1864, Farragut, free from his duties on the Mississippi, made a reconnaissance of the forts at the mouth of the bay; and, finding present no Confederate vessels except one transport, he desired to be allowed to force the harbor entrance before the more powerful Confederate vessels could be finished and brought down to aid in the defense.

In the latter part of February, light draught vessels of the Federal squadron attempted to enter Mobile Bay from Mississippi Sound; but, as the vessels could not get within effective range of Fort Powell, they returned after several shots had been exchanged.

In July, several expeditions were carried out: a blockade runner was beached under the guns of Fort Morgan and burned; and many night searching parties were sent out by the Federal fleet in attempts to locate and pick up mines, or torpedoes, as they were then called.

On May 18th, Admiral Buchanan, commanding the Confederate naval forces at Mobile, planned to make a surprise night attack on the blockading vessels; but, due to various mishaps, it was daylight before the *Tennessee* came down the bay, and as she was then recognized by the Federal fleet, no attack was made. At the next tide she was floated farther down the channel and anchored under the guns of Fort Morgan, where she remained till the 5th of August.

Toward the end of July, plans of operations for the Federal forces were agreed upon between General Canby and Admiral Farragut. Farragut's plan was to pass up the channel close under the guns of Fort Morgan, destroy the Confederate naval forces, and support the Army, which, in the meantime, was to land and invest all three forts at once, without undertaking siege operations.

That plan, however, had to be changed, as General Canby was obliged to detach a force to protect Washington; so a second plan was adopted at the suggestion of Admiral Farragut. This contemplated that the military forces should land on Dauphine Island from Mississippi Sound, under cover of gunboats; and August 4th was selected as the date to begin operations.

This, however, was changed by circumstances. Admiral Farragut was required to postpone his operations twenty-four hours, waiting for the *Tecumseh*, a monitor, to come from Pensacola, in order the better to engage the *Tennessee;* while General Granger, in immediate command of the military forces, landed on Dauphine Island some seven miles from Fort Gaines, on the afternoon of the 3rd and immediately began its investment. In this way, the attack on Fort Gaines opened the operations, and the Confederates, unhampered by a Federal naval force, rushed additional troops and supplies to the forts's assistance.

The works about Mobile were at that time the most formidable in the South.

The troops (about 1500) under General Granger immediately took up the advance, and by midnight of the 4th the light artillery was in position some 1200 yards from the fort, and the next morning opened up on the works simultaneously with the passage of the batteries by the fleet.

Turning our attention to the fleet, which now played the most important rôle, we learn that on the afternoon of August 4th Farragut, accompained by the commanders of his vessels, ran into the harbor on a small tug to make a final inspection of the defenses. About this time two Confederate transports came down the bay and began landing troops and provisions at

Fort Gaines. These vessels were driven up the bay by the *Winnebago*, which came up and opened fire. The tug returned and the various officers rejoined their vessels. Detailed orders* were issued by Farragut for the attack to be made the next morning. Vessels were ordered to move together in pairs, lashed together, the larger ship on the starboard side, so in case one was disabled, the other could be depended upon for motive power.

The *Brooklyn* was paired with the *Octorara*, the *Hartford* with the *Metacomet*, the *Richmond* with the *Port Royal*, the *Lackawanna* with the *Seminole*, the *Monongahela* with the *Kennebec*, the *Ossipee* with the *Itasca*, and the *Oneida* with the *Galena*.

Admiral Farragut intended to lead with the *Hartford;* but, yielding to the solicitation of his officers, he consented to let the *Brooklyn* go ahead, as this vessel was fitted with an apparatus for catching torpedoes (mines) and also had four bow guns which could be used when approaching the Confederate works.

The monitors were to go in single file, a little ahead of the wooden ships, in the following order: *Tecumseh*, *Manhattan*, *Winnebago*, *Chickasaw*. They were to engage, and keep down the fire of, the water battery and parapet guns of the forts, as well as to attack the Confederate ram *Tennessee*, as soon as Fort Morgan had been passed.

Admiral Farragut planned to move past the forts, for, believing the mines planted in the channel were probably innocuous, having been some time in the water, he determined to take the chance.

In order to have rapid communication with the army forces ashore, signal officers of the Army were distributed among the principal vessels.

The steamers *Genesee*, *Pinola*, *Pembina*, *Sebago*, *Tennesee*, and *Bienville*, not being part of the attacking fleet, were directed to take up a position southeast of Fort Morgan and to keep up a flank fire; but they were unable to get near enough to the work to take an important part in the action.

The fleet got under way at 5:30 A.M., crossed the bar at 6:30 A.M., and at 6:45 A.M. the *Tecumseh* fired the first two guns, one shell being seen to explode over Fort Morgan. For the time, there was no other firing. It was a clear day, the wind

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* See sketch, *Official Records of the Union and Confederate Armies*, Part I, Vol. 39, page 409.

blowing towards the fort, and the tide coming in. At 7:06 A.M. Fort Morgan opened fire. It was intended that the monitors should take the lead and draw the first fire of Fort Morgan. During this time the rest of the vessels kept coming on, the *Brooklyn* coming up to the monitors. At 7:10 A.M. the *Brooklyn* opened fire and the rest of the fleet followed as soon as their forward guns bore. Ten minutes later the Confederate ram *Tennessee* came out. The *Hartford* did not open fire till five minutes after Fort Morgan, and it then engaged the fort, driving the Confederates away from their batteries by its broadsides, but they returned to their guns whenever opportunity presented. The light breeze at this time dying down, the smoke settled down around the vessels, and the gunners in the fort were unable to see them distinctly. At 7:15 A.M. signal was made for closer order; and at 7:20 A.M. the larger vessels were busily engaged attacking with their broadsides, while the monitors ran under the guns of the fort, delivering a heavy fire. The *Tecumseh* struck a mine and sank in about thirty seconds, taking along almost its entire crew.

It was at this time that the *Brooklyn* slowed down, reported that mines were ahead, and apparently expected orders for its further action. The signal was received by the flag-ship: the Federal vesels were coming on, and in a very short while all would be in confusion immediately in front of the guns of Fort Morgan. Admiral Farragut, seeing the conditions of affairs, turned to his pilot, asked if there was sufficient water ahead, and receiving an affirmative answer, gave the direction "Full speed ahead," and took the lead with his own vessel, thus straightening out his column, and preventing by his quick action what might have been disaster. The *Hartford* went right through the Confederate mine field, mines being heard striking the bottom and sides of the vessel, but fortunately none exploding.

It was 7:32 A.M., when the *Hartford* took the lead, and at 8:35 A.M., she anchored above the forts, the rest of the fleet being then in the harbor and out of range of the guns of Fort Morgan.

Before taking up the part played by Fort Morgan, let us turn our attention to the Confederate vessels previously mentioned.

As the Federal fleet came on, the monitors in single line-ahead and the rest of the vessels paired in double line-ahead, about a quarter of a mile in rear of the monitors, signal was made by the Confederate ram *Tennessee* to get under way, and the Confederate vessels formed line-abreast towards the oncoming Federal fleet.

As the fleet was opposite Fort Morgan, the *Tennessee*, lying just beyond the line of torpedoes, approached and opened up on the leading vessel; she made an attempt to ram the *Hartford*, but, due to the latter's superior speed, the attempt failed. The *Tennessee* then headed for the *Brooklyn* and failed again for the same reason—the Federal vessels, due to their superior speed, were able to outmaneuver their assailant. During this time, the three gunboats were closely engaged with the Federal fleet. The *Gaines* fought on till she was in a sinking condition, when she was run ashore near Fort Morgan; the *Selma* is said to have deserted the *Gaines* in the action, and surredered later when another large vessel came on; and the *Morgan* managed to escape to Mobile.

Thus the Confederate gunboats were effectively disposed of by the superiority of fire of the Federal fleet, leaving at this time the *Tennessee* still to be put out of action. The coupled ships were unlashed and the final engagement begun. The ships in this encounter suffered far more than when they ran by the forts. All vessels that could get to her attacked the ram, and she was rammed some six or eight times, but without much effect. Whole broadsides of 9-inch and 10-inch guns were fired at her, some at point blank ranges three to thirty yards away; and, finally, Admiral Buchanan being wounded, the rudder chains carried away, the smoke stack knocked off, and the shutters of gun ports jammed by a 15-inch shell fired from the *Manhattan*, the *Tennessee* surrendered, about 10 A.M. This fight had lasted about three quarters of an hour.

Turning now to the part the forts took in this naval action, we find that Fort Gaines played but a small part.

Fort Powell was abandoned the night follwing the fleet's entrance into the harbor, after having been bombarded in the afternoon at 2:30 P.M. by the *Chickasaw*. It had taken but a minor part in the action and its position had become untenable.

Fort Morgan bore the brunt of the attack by the monitors and the fourteen other vessels, whose total broadside was approximately seventy-five guns. In the fleet's approach some thirty bow guns were available. Although the fleet had actually 199 guns, only part of them could be brought into play.

A broadside fire maintained by the fleet so far silenced the fort that its guns did comparatively little injury during the run-by. But after the ships had passed, the guns were manned again and opened up with a furious cannonade. It was at this time that the *Brooklyn*, mistaken for the *Hartford*, had the fort's fire concentrated on her, and was struck some thirty times in the hull and rigging.

The fleet was in effective range of Fort Morgan for about one hour, and during this time the fort fired 491 projectiles, or an average of eight per minute. The monitors closing in on the fort were severely handled, the *Winnebago* being hit some 19 times.

The *Oneida* and the vessel with her also suffered severely from the fort's fire, being raked fore and aft. The *Oneida* had her boilers shot through.

The fire of the forts did not, however, stop the fleet; nor, on the other hand were they disposed of by the fleet: both Fort Gaines and Fort Morgan were compelled to surrender only after having land forces brought against them.

The second part of the operations in Mobile Bay, the reduction of the forts, will now be taken up.

The first plan of operations contemplated a landing of 3000 men upon Mobile Point from the outside and opposite Pilot Town (three miles from Fort Morgan) simultaneously with the passage of the fleet into the bay. A sufficient force was to move immediately to a position at a certain range from Fort Morgan—a mile or three quarters—suitable for rifled guns and mortars, there intrench and open fire with available guns (eight 30-pdrs., six 3-inch Rodman guns, and two mortars), in cooperation with the fleet. The remainder of the force was to intrench itself across the spit at Pilot Town against approaches from the mainland. A reserve of 1500 men with field artillery (rifled guns) was to be kept aboard ship in Mississippi Sound (inside Dauphine Island), with a view to some portion of it landing, if not required eslewhere, moving up and annoying Fort Gaines in conjunction with the fleet after its passgge up the bay. Thus with these dispositions, Forts Morgan, Gaines, and Powell could be separately and effectively invested. No siege, employing regular approaches and breaching batteries, was comtemplated, for the means were not at hand; nor was it considered necessary.

It was found, however, that only 1500 men were available; so the following plan was adopted: the whole force, including all the artillery, was to land on Dauphine Island and go into position against Fort Gaines, as had been proposed against Fort Morgan, the fleet from the sound, from the bay (a portion then being in the bay), and from the anchorages outside, concentrating all their efforts against Forts Gaines and Powell; the fall of one of these works, or of both, would open up communication with the portion of the fleet inside and enable the Federals to enter the bay with troops, effect a landing at Pilot Town, and proceed against fort Morgan as originally contemplated.

A landing was made on Dauphine Island at 4 P.M., August 3rd; at 10 A.M., August 4th the line of sentinels was within 1200 yards of the fort; and at 4 P.M. work was commenced on a line of trenches, with batteries, across the island. During the night six 3-inch Rodman guns were put into position on the ridge of sand.

On the 5th, at sunrise, the fleet started on its way by the forts, and the 3-inch guns opened fire on Fort Gaines. The fort replied but did no damage.

After the fleet's entrance, and while it was engaged with the ram *Tennessee,* Fort Gaines opened up on it with two 10-inch columbiads which bore upon the scene of action; these, however, were soon silenced by the field guns from the sand hills, which took the columbiads in reverse and flank, they being protected by neither parados nor traverse.

On the 6th, the *Winnebago* approached within half a mile of Fort Gaines and fired upon it. Many of the shells burst over the fort, taking the opposite sides well in reverse, there being no parados nor traverse. The fort replied with its 10-inch gun, but did not hit the monitor. At night, Fort Powell was blown up and abandoned by the Confederates.

On the 7th, four 30-pdrs. and six field guns were nearly ready to fire and the infantry trench was nearly complete.

At 10 A.M., on the 8th, the fort surrendered. The garrison consisted of 818 officers and men. Its armament was found to be:

4 10-inch columbiads
2 7-inch Brooke rifles
12 15 S.B., 32-pdrs., and 24-pdrs.
and five or six flank casemate howitzers.

Two 10-inch guns and six 24-pdrs. commanded the land approach.

There was an abundant supply of ammunition and rations for two months.

In the fort there was neither merlon, traverse, nor parados to protect the guns, nor splinter-proof for the personnel. It was utterly weak and ineffectual against the Federal attack, which could have taken all its fronts in front, enfilade, and reverse. With the guns on the sand ridge before mentioned, every shot could have been placed upon the terreplein of the opposite fronts. This sand ridge afforded perfect cover up to a point 400 yards from the fort, its height varying from 15 to 30 feet, and the crest of the fort being 27 feet. The garrison had commenced four traverses, but had made little progress on them.

On August 9th, Fort Gaines having surrendered, transports with 2000 troops and all available siege material were moved to Pilot Town and there landed, passing without interruption within two miles of Fort Morgan. The landing commenced about 11 A.M., and at 4 P.M. the advance was moved up and occupied a line 2000 yards from the fort. The outer batteries, Gee and Bragg, were abandoned by the Confederates.

A reconnaissance was made, and an abandoned line of trenches constructed by the Confederates and extending nearly across the island, was found. The terrane being favorable, it was decided to convert this, with but slight changes, into the first parallel and put into position there the 30-pdr. Parrott and other long range guns, although the distance (1400 yards) was somewhat greater than desirable. That night the advance occupied this trench. Work was now done bringing up the guns and mortars and selecting suitable positions for them.

On August 11th, 12th, and 13th the monitors *Chickasaw*, *Winnebago*, and *Manhattan* in turn came up at about 1800 to 2000 yards off the fort and fired shells, one every half hour during four or five hours in the morning and for the same length of time in the afternoon. Sometimes this firing was kept up during a part of the night.

On August 14th, the siege gun battery on the left (Battery H*) and two 30-pdr. Parrotts were ready to fire. The other batteries were ready for their platforms. Federal sharpshooters were occupying all the most advanced sand hills and in some cases were within 250 yards of the works. The fire of the fort caused but little disturbance, as the sharpshooters made it rather hazardous to serve the guns, which were not in embrasures. At 6 A.M., fire was opened with the 30-pdrs. Three of the fort's barbette guns appeared to be dismounted and the parapet considerably injured by the previous bombardment of the monitors.

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* See map in Atlas accompanying *Official Records of the Union and Confederate Armies*, plate LXIII, to which the letters here used to designate batteries and positions, refer. That map is here reproduced, opposite page 330.

On August 15th, work was commenced on Batteries A and B, and that night the second parallel was commenced, running from the left extremity of the sand ridge behind which the mortars had been located.

August 16th, twelve additional siege mortars arrived, making sixteen in all. These were to be located behind the sand hills near Batteries A and B. During the night the parallel was finished half way across the point. The fort kept up its fire, but did no particular damage.

On August 17th, Battery G was completed for two 9-inch guns (Navy) and all guns mounted in other batteries were connected with the first parallel, except Battery F. Work on the second parallel was continued.

August 18th, the second parallel was continued to P and a battery for two light 12-pdr. guns was located and commenced at O. Two batteries for mortars were begun at E and K. Four 9-inch Navy guns were landed, and two of them placed in position at G. Platforms for twelve mortars were completed at A, B, C, D, and L and the mortars were mounted. There was no anoyance from the fort.

On August 21st, magazines, platforms, and batteries for all guns and mortars on hand were completed and everything was ready for opening fire. At 8:45 that night the fort commenced firing, but there was no response from the Federal siege guns.

The monitors maintained their positions as before, firing an occasional shell into the fort.

At daylight, August 22nd, fire was opened up by the Federal siege batteries consisting of:

4	9-inch Dahlgrens
8	30-pdr. Parrotts
4	light 12-pdrs.
2	3-inch Rodmans
12	10-inch siege mortars
4	8-inch siege mortars.

The Monitors *Manhattan*, *Chickasaw*, *Winnebago*, and the

captured ram *Tennessee* (eight 7-inch rifles) fired at the fort at short range, while the rest of the fleet fired at long range with large rifled guns.

The fire was accurate. The mortars fired at first once every 15 minutes, slackening down at noon and resuming near sundown. No artillery was fired from the fort; two volleys of musketry were fired from the southeast salient of the covered way, but this was soon silenced by the Federal fire. Some of the light guns were moved up nearer to the fort. At night an approach zigzag was started from the left extremity of the second parallel, but was not run to any distance on account of rain and mud. About 9 P.M. that night a conflagration broke out in the fort and the Federal artillery fire, which had practically ceased at night fall, was resumed.

It is estimated that in the last twelve hours of the siege 3000 projectiles were thrown into and around the work.

On August 23rd, at 6 A.M., there was an explosion in the [illegible] fort; at 7 A.M. a white flag was flying, and surrender was [illegible] arranged for 2 P.M. The conflagration of the night before was [illegible] still burning; it was in the barracks which were in ruins, nearly [illegible] *all the* wood work having been burned out. The scarp [illegible] *parapet* of the fort were much torn up by the shells fired by [illegible] Navy. No casemate arches were broken, nor any [illegible] injured. The carirages of the 8-inch and 10-inch [illegible] situated in front of the 3-inch rifles (Federal) were [illegible] Twelve of the barbette guns were disabled.

Of the ammunition on hand there were found 250 [illegible] per gun, except in the case of the flank howitzers, for [illegible] there were but 50. The powder was practically all [illegible] stroyed.

The efficiency of the land defense was much [illegible] to the fact that the Federals could approach under perfect [illegible] to within 500 yards of the fort behind the sand hills [illegible] north shore and behind the ridge near the south [illegible] there very easily establish batteries. Moreover, the [illegible] could not be worked owing to the sharpshooters firing [illegible] Federal works.

Fort Morgan surrendered, as General Page, its [illegible] in his report states, because the parallels of the [illegible] reached the glacis, because the walls had been breached, [illegible] all the guns save two had been disabled, because the [illegible] of the citadel had been set on fire by shells of the [illegible] thereby endangering the magazines, and because all [illegible]

captured ram *Tennessee* (eight 7-inch rifles) fired at the fort at short range, while the rest of the fleet fired at long range with large rifled guns.

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Of the ammunition on hand there were found 250 rounds per gun, except in the case of the flank howitzers, for which there were but 50. The powder was practically all destroyed.

The efficiency of the land defense was much reduced due to the fact that the Federals could approach under perfect cover to within 500 yards of the fort behind the sand hills along the north shore and behind the ridge near the south shore, and there very easily establish batteries. Moreover, the guns could not be worked owing to the sharpshooters firing from the Federal works.

Fort Morgan surrendered, as General Page, its commander, in his report states, because the parallels of the Federals had reached the glacis, because the walls had been breached, because all the guns save two had been disabled, because the woodwork of the citadel had been set on fire by shells of the Federals, thereby endangering the magazines, and because all powder had been destroyed by flooding, for fear of the magazines being bombarded.

In the surrender were included some 600 prisoners and 60 pieces of artillery of various kinds.

In these attacks, there was no immediate expectation of moving on the City of Mobile, which was safe, by reason of a solid row of piling and mines across the river three miles below the city; nor could the larger vessels get within three miles of the city on account of shallow water. But by the operations in the lower bay Mobile was effectually closed as a port for blockade runners, although the city itself was not taken till later.

AMMUNITION AND CASUALTIES

The *Hartford* expended a little over 200 rounds; the *Brooklyn*, 183; the *Richmond*, 193; the *Lackawanna*, 105; the *Monongahela*, 99; the *Ossipee*, 93; the *Octorara*, 8; the *Seminole*, 36; the *Kennebec*, 33; and the Monitors *Manhattan*, *Winnebago*, and *Chickasaw*, 11, 56, and 183 respectively. For other vessels the expenditure is not definitely stated.

The hits on the vessels were as follows:

Hartford	20
Brooklyn	30
Octorara	11
Lackawanna	5
Kennebec	2
Galena	7
Manhattan	9
Winnebago	19
Chickasaw	3
Metacomet	11
Ossipee	4
Itasca	1

The *Tecumseh* was sunk, as was also the *Philippi*. Others escaped with but minor damage.

The casualties in the fleet were:

	Killed	Wounded
Hartford	25	28
Brooklyn	11	43
Lackawanna	4	35
Oneida	8	30
Monongahela		6

	Killed	Wounded
Metacomet	1	2
Ossipee	1	7
Richmond		2
Galena		1
Octotara	1	10
Kennebec	1	6
Total	52 killed	170 wounded

This does not include the loss due to the sinking of the *Tecumseh.*

It is noted that of the above casualties more are to be attributed to the action with the *Tennessee* than to the fire of the batteries of the forts.

On the Confederate side the *Tennessee* was struck 53 times, from 33 of which resulted penetrations of greater or less degree. She had 2 killed and 9 wounded. The *Gaines* was hit 17 times and had 2 killed and 3 wounded. The *Selma* had 10 killed and 16 wounded.

The casualties of the land forces, both Confederate and Federal, were very small. In the siege of Fort Morgan the Federals lost 1 killed and 7 wounded.

As to the expenditure of ammunition during the siege of Fort Morgan by the ironclads, we may take the data of the *Manhattan* for example, as follows:

Date	Time	Rounds fired	Range, yards
Aug. 9th	10:30 A.M. to 1 P.M.	15	1300
13th	7:00 P.M. to 9 P.M.	8	1400
14th	2:00 A.M. to 4 A.M.	6	1200
15th	2:00 A.M. to 5 A.M.	14	1200
"	7 P.M. to 10:30 P.M.	8	1200
19th		6	1200
22nd	5 A.M. to 7:15 A.M.	13	1200-1000
23rd	10 A.M. to 11:30 A.M.	12	1000
"	5:15 P.M. to 7:00 p.M.	18	surrender

The fort, replying to this fire on the 9th, hit the monitor once; and replying on the 15th, had one shell burst over the deck. Further data are not available.

The besieging force fired as follows:

Battery B	298 shells
Battery F	285 "

Battery H	200 shells
Battery K	223 ”

There was, of course, more ammunition expended, but no further data are available.

Campaign against the City of Mobile

After the forts had been taken, operations in front of Mobile ceased. Then on December 16th, 1864, when Thomas had overthrown Hood at Nashville, he was ordered to follow Hood south; but in January this movement came to a stop at Eastport, due to the condition of roads. Subsequently General Grant ordered General Canby, then at New Orleans, to move against Mobile. Meanwhile, the city had been further strengthened since the Battle of Mobile Bay, the preceding August, and was now defended by three main lines of fortification on the west side. General Canby, therefore, determined to attack from the east side, where, also, he might have the cooperation of the Navy. The principal works to be reduced were the Spanish Fort, commanding the mouth of the Appalachee, and Fort Blakely, commanding the head of the Appalachee, where the Tensas leaves it.

The movement was made in two columns—one from Dauphine Island under Canby, the other from Pensacola under Steele.

Canby's force was about 32,000, accompanied by a siege train; and Steele's force numbered about 13,000; so in all there was an attacking force of 45,000.

Mobile was held by a force, under General Maury, of an approximate strength of 10,000, with some 300 field and siege guns. There were also five Confederate gunboats.

Canby's advance began March 17th, part of the troops, the 16th Corps coming from Fort Gaines, and the 13th Corps from Fort Morgan. These forces united near the mouth of the Fish River and began the siege of the Spanish Fort on March 27th. On the 8th of April, the trenches were well advanced and a bombardment was begun by ninety guns and joined in by all the Federal gunboats within range.

In the evening, a lodgement was effected on the right of the Confederate lines; and, during the night, the Confederate garrison made good its retreat with a loss of some 500 prisoners. Nearly ninety guns were left behind.

Steele's forces left Pensacola on March 20th, and after a roundabout march of over a hundred miles arrived before Fort

Blakely on April 1st, and at once began the siege. On the afternoon of the 9th, twenty-eight guns were in position; and the Spansih Fort having fallen, the Confederate works were captured by a general assault made by 16,000 men. There were taken 3423 prisoners and more than forty guns.

Forts Tracy and Huger, two small works, were abandoned and blown up on the night of the 11th.

The rivers were swept for torpedoes, and the fleet then gained the rear of Mobile by the Blakely and the Tensas. On the morning of the 12th General Granger crossed the bay under convoy of the Navy and entered Mobile. Maury had by this time marched out with the remainder of his force, some 4500 men and 27 field pieces, and retreated towards Meridian. Subsequently, this force, as part of the Confederate armies, was surrendered to General Canby, May 4th, 1865, when the war was over.

The naval operations during this time supplemented those of the Army, keeping open a water line of communications reconnoitering the various bays. The Navy aided in the land operations with its fire when practicable, and also put ashore and manned some of its guns as siege batteries, as in the siege of the Spanish Fort. It shelled Batteries Huger and Tracy. The monitor fleet finally appeared in the river in rear of Mobile and hepled to compel its surrender.

The Navy suffered its greatest loss from contact with mines. On March 28th the *Milwaukee* struck one, and sank in about three minutes; there was, however, no loss of life. On the 29th the *Osage* struck one and sank, with a loss of 5 killed and 11 wounded, due to the explosion. On April 1st the *Rodolph* struck a mine, its loss being 4 killed and 11 wounded. Later in clearing the channels—where in one case 150 mines were taken out of the rivers—the tugs *Ida* and *Althea* and a launch were blown up, resulting in 8 killed and 5 wounded. On April 14th, the gunboat *Sciota* was sunk by a mine, having 6 killed and 5 wounded.

COMMENTS

1. In the attacks just described, we have one of the best examples of mutual dependence of the Army and Navy and of thorough understanding of each other's sphere, which contributed much to their successful issue.

2. The subordination of military affairs to those that may be called political, is brought out here; for had the Admin-

istration been able to see how easily the attack could be made, if made earlier, much would have been saved.

3. An example of the successful use of *mines*—although the mine *fields* were not efficient. This illustrates what an English writer has said on mines—that to be of use, mines must have one hundred per cent efficiency.

4. The large factor of chance that enters into the successful passage of a mine field—of the attacking fleet only the *Tecumseh* was sunk; but its loss was complete.

5. We see again familiar causes bringing about the surrender of forts—a military force landing on an island on which a fort is located, resulting in the loss of military control on the part of the fort commander, comes ultimately to mean the loss of the fort itself. A force retiring within works invites surrender—the only question is, How soon? Port Arthur also illustrates the point, that a garrison taking refuge in a work is doomed.

6. Another example of the faulty construction of a work to withstand a land attack. The federal landing operations should have been stopped.

7. An example of the successful use of obstructions, compelling the attacking fleet to move in well defined channels, thereby bringing it under the fire of the forts.

8. Would the passage of a modern fleet over a modern mine field offer any chance for success? is a question for the coast artillery of to-day to answer.

AUTHORITIES

Official Records of the Union and Confederate Armies, Series I, Vol. 39, part 1, pages 402-457; part 2; Index and Atlas.

Official Records of the Union and Confederate Navies, Series I, Vol. 21, pages 397-601.

Battles and Leaders of the Civil War, Vol. IV, pages 379-413.

The Gulf and Inland Waters, Mahan (Scribner Series), pages 218-251.

The Blockade and the Cruisers, Soley (Scribner Series), page 132 *et seq.*

The Monitor and Navy under Steam, Bennett, pages 203-212.

History of the Navy, Maclay. Vol. II, pages 396-456.

Artillery Notes, No. 28, pages 49-59.

PROFESSIONAL NOTES

THE FORTIFICATIONS OF ADRIANOPLE

Translated from the German for the JOURNAL OF THE UNITED STATES ARTILLERY by 2nd Lieutenant Donald Armstrong, Coast Artillery Corps

The siege and fall of Adrianople in the Balkan war has called forth greatly varying opinions of the value of fortifications in general and of the fortifications of Adrianople in particular. The opinion that Adrianople as a modernly constructed fortress could have offered resistance for only five months certainly has not been proved, for the modernization of the fortress was commenced only a short time before the war commenced, and it would have required years of labor before it could have been called a modern fortress. A high ranking Russian officer, who visited the theater of operations in the spring of 1913, published a thorough description of the siege of this fortress under the title *The Fight around Adrianople* in the Russian Engineer Journal. Of special interest are his accurate statements concerning the condition of the fortifications. The author writes as follows:

"The terrain was favorable to the defense in the highest degree; and this, in conjunction with the abundance of materials (it is a large town with groves and gardens), offered the opportunity for an energetic commander to conduct an extremely obstinate defense, despite the unfinished condition of the fortifications. Shukri-Pasha by no means proved to be such a commander and in no way deserves the appellation of 'The Unconquerable.'

THE NORTHWEST FRONT

"The northwest front was the most strongly fortified of the entire fortress.

"The northerly (right) section of this front consisted of a group of two works, a system of trenches, and nine batteries, of which four were armed with guns of larger caliber (4.7-inch and 6-inch). This group lay on the Karagios-Tarla hill, seven kilometers from the city.

"Both the works, Jeschil-Tepe and Jassy-Tepe, were of temporary construction with glacis-like parapet. In the front wall there were light shelters which were of value only against shell splinters and shrapnel.

"Construction of these works had commenced only a short time previously, and the fronts and parts of the flanks were completed. The bright color of the parapet was in great contrast to the color of the surrounding terrain, and consequently visible for long distances. The principal defensive position was formed by the trenches, which blended very cleverly with the landscape and were well concealed from observation. Fifty-five yards in front of the entire group a wire entanglement, eight yards wide, was erected on iron posts. The concrete ammunition magazine for this front was placed about 1100 yards in rear. In addition to this, each battery had a magazine made of wood or sheet metal, which afforded protection against splinters.

"In front of these works and about 2200 yards to the north was an advanced position on the Jutsch-Tepeler hill which consisted of a group of trenches together with connecting trenches and earthen huts on the reverse slopes.

"The southerly (left) part of the northwest front consisted of works on a moderately high ridge, from which an excellent field of fire was available up to extreme ranges. In rear of this the terrain was well concealed from the view of the besiegers, and offered favorable positions for batteries emplaced in the manner which the Germans have successfully employed. The principal defensive position was on this ridge and consisted of three works, twenty-seven batteries, and trenches in the intervals. From the Tundscha to the Mariza, along this entire front, stretched an uninterrupted wire entanglement.

"The principal work and the strongest work of the entire fortress lay on the right flank, viz., the Schaitan-Tarla work (also called Karagios-Tabia) on a hill of the same name. It is a closed work of old style construction—high ramparts with hollow traverses built of brick. A trench was dug in the glacis and in front of that a wire entanglement had been constructed. The gorge was also prepared for infantry defense, but no wire entanglement was provided there. On the flanks of the work, barracks had been built for two companies, in place of the old batteries.

"About 3300 yards south of Schaitan-Tarla is the work Kasan-Tepe on a hill from which there is an excellent view. Kasan-Tepe is a semi-permanent lunette, the front of which has a glacis-like profile. A wire entanglement is also stretched in front of this fortification. In the interior of the work there are barracks of natural rock in cement, although the front walls are of concrete.

"This work would have been the strongest work in the entire fortress, if the rear had been properly protected by gorge defenses. But, as there was no gorge at all, Kasan-Tepe could easily have been taken from the rear, in case the enemy had penetrated the main line; consequently, this could not really be considered a supporting point.

"The third work of the left part of the northwest front was Kasan-Kjuprju, only 800 yards from Kasan-Tepe. Its value was nil, as the construction of it had just begun and it was merely a shapeless mass of earth.

"*The strength of the northwest front lay entirely in the field fortifications constructed in the intervals between the permanent works; and those field fortifications consisted mainly of fire trenches which had been carefully concealed from the view of the enemy and blended well with the terrain.*

"The trenches mutually supported one another and each flanked a portion of the entanglements.

"The batteries were emplaced a short distance in rear of these trenches (160-220 yards), concealed from sight and well blended with the landscape. Some of the batteries were of concrete and armed with 6-inch guns and 8-inch mortars on sea-coast carriages, having all-round fire. The effective range of these guns was accordingly very great. As the fortress was of comparatively small diameter, these batteries could fire over the city and support the artillery of the other fronts. The concrete roofs of the traverses of these batteries were only 18 inches in thickness, so that they could be penetrated by a single direct hit of the latest 6-inch howitzers with which the Servians were supplied.

Moreover, the batteries were badly constructed, for they were destroyed by the firing from their own guns. The roofs were cracked, the foundations were damaged, and the concrete covering of the parapet fell in. In this part of the northwest front were two concrete magazines and a number of others built of lighter materials.

"In front of the main position, field fortifications consisting of trenches and field batteries formed advanced positions at the village Kadünkoj and at the farm Jekmekschi-Köj.

"The construction of this part of the front was commenced, with the exception of Karagos-Tabia, later than 1908, its function being to keep the artillery of the attack at a distance, which function was only partially fulfilled. (Kasan-Tepe was about 5500 yards from the city.) In order to eliminate as far as possible danger from the artillery of the attack, advanced positions were occupied and were successful in accomplishing their purpose.

"In rear of the main position there was a second line which consisted of the three old forts, Basch-Juk-Tepe, Kemer-Tepe, and Ainaly-Tepe, and several temporary batteries. These batteries lay with their front towards the north and could fire upon the intervals between the Karagios-Tarla and the Schaitam-Karla groups. The keep of the entire front was the ancient but well preserved Fort Chedyrlyk, on a hill about 1600 yards from the city in the vicinity of the suburb of the same name. The commandant of the fortress, Shukri-Pasha, with his staff, took up abode in a roomy brick barracks in this fort. Here also was the wireless telegraph station which maintained communication with Constantinople.

"This northwest front just described was the best front for the attack. The terrain favored the emplacement of siege guns, and the best lines of communication from the Bulgarian border for bringing up siege materials led to this front. At the instigation of their German instructors, the Turks had directed their principal attention to this front, and had undertaken its improvement methodically.

"From a critical consideration of this front, it must be admitted that tactically the problem was well solved: the positions of the supporting points were well selected; the fortified groups were porperly placed and mutually supported each other with their fire; the batteries blended well with the landscape; and the three special groups of advanced positions were protected by fire from the main works, the approaches to which they, on their part, flanked, and during active operations by the troops they served as supporting points.

"Technically, the solution of the problem was unsatisfactory. The work of building the fortifications had just commenced, and as a result they were not completed. These works cannot be classified as forts, at best being only infantry works. They were apparently types of the German "storm-free" works, although they lacked mutually supporting fire, connected obstacles, permanent obstacles, ditch defense, cover against heavy caliber fire, and casemated defenses in the intervals.

"They were not suited for artillery positions as they were not well concealed from view and their front was too narrow—only 110 to 165 yards in extent. Firing from them during an artillery bombardment must have been an impossibility. The concrete barracks afforded protection only against 6-inch howitzers. This was the only advantage the defense secured from these works, for if the enemy succeeded in breaking through the line they were absolutely of no value.

"The permanent batteries in the intervals, from a technical point of view, are decidedly open to criticism. The roofs of the traverses fell in on the impact of 6-inch projectiles and cracks were even made in them by their own firing.

"The intervals in no way satisfied the demands which must be fulfilled in positions of a permanent character. *They were purely and simply field fortifications, and it is only due to the circumstance that they were well concealed and had favorable profiles (very low parapets) that the intervals had great strength of fire and suffered only slightly under artillery fire. Moreover, on the intervals depended the entire defensive strength of the front.*

"The uninterrupted wire entanglement which was stretched in advance of this entire front, must be regarded as a gross technical error. This wire entanglement entirely denied the defenders the chance of making sorties, and limited them to purely passive operations.

"The concrete ammunition magazines were better than the other works constructed; and the well developed system of roads and narrow-gauge railroads also was good.

THE WEST FRONT

"The west front of the fortress occupied the hilly country between the right bank of the Mariza and the left bank of the Arda. It extended from east to west in the form of a triangle whose vertex lies at the confluence of these two streams near the village Marrasch. A line of single hills rise from the valley of the rivers to a height of over three hundred feet. The tops of these hills are flat, and the slopes steep. The most important hill from a tactical point of view is called Papas-Tepe, from which the entire position of the west front derives its name. This position is very strong by nature, the flanks being protected by the rivers, and the slopes of the position being very steep.

"From the point of view of the military engineer, the position of Papas-Tepe is exclusively a group of field fortifications. The most important construction of the group was a work for a battalion, designed for all-round fire, with communication passages, earth huts on the rear slopes, and a wire entanglement encircling it completely. This point of support lay on the Papas-Tepe hill. On the hills 1100 yards to the west were fire trenches for a regiment, and the same thing to the east on the heights Bektschi-Tepe. The latter served as a keep for the enitre group. Two batteries of 4.7-inch field howitzers were emplaced in well concealed positions in the vicinity of the strongest work of this front. Thus the west front, while composed of field fortifications, possessed considerable strength.

THE SOUTH FRONT

"The south front of the fortress between the right bank of the Mariza and the right bank of the Arda is of a generally level character. The ground in front of the suburb Karagatsch rises gradually from the valleys of the Mariza and Arda towards the southwest, and forms a plateau of but slight elevation. About 8000 to 9000 yards from Karagatsch are foot hills of the Balkan Mountains range, the highest of which is called 'Kartal-Tepe.' The rolling character of the terrain makes it possible so to emplace the batteries that it is difficult to detect the position of the guns, for even though they come under the observation of the enemy, he cannot tell behind which line of hills the batteries lie.

"The principal fortifications consist of four old forts and thirteen batteries. In the valley of the Mariza near the village Bossna-Koi lies a fort of the same name. Twenty-two hundred yards from this fort there is a second fort near the village Demirdesch. Over 3000 yards beyond, lies Fort Karagatsch close by the suburb, and 1000 yards beyond this, Fort Marasch, the right wing of the south front.

"The ancient and valueless work Merkes-Tabia is located near the railroad between Forts Demirdesch and Karagatsch.

"All the forts were out of date, of the well known types constructed around the year 1885. The project of 1908 called for an advance of the defensive line toward the south in order to prevent artillery fire from damaging the railroad station and the town of Karagatsch. The Turks began the actual work on the project, in conformity with the views of their German instructors, with the construction of the batteries, and consequently they are located in advance of the line of forts. Some of the batteries were concrete and others were more hastily built. The magazines were only temporary buildings.

"Trenches had to be dug for the protection of these batteries, and on the left flank a redoubt was built. In addition, a wire entanglement was stretched from the Mariza to the Arda. There were also a number of advanced positions 5500 to 8000 yards in front of the batteries: 'Pamuk-Ssyrty,' 'Tokat-Bain,' 'Kartal-Tepe,' and 'Doudsharos.' *All these advanced positions during the siege were constructed as field fortifications; but the Turks held them for fully five months, so they must be designated the chief defensive positions of the south front.* Thus the south front was composed principally of field fortifications, and it must be noted that in the majority of cases the wire entanglement was in rear of the defensive line. As far as the terrain is concerned the advanced positions were well chosen, but the batteries lay too far off to be of assistance in supporting the infantry positions.

THE NORTHEAST FRONT

"The northeast front between the left bank of the Tundscha and the left bank of the Mariza was divided into a north and east section. The north section extends from the Tundscha to the ruins of the village Arnautköj. It is within range of the Karagios-Tarla group of the northwest front, and is divided into a level and a hilly part by the little stream Prowadisk. The level part did not appear to the Turks to be secure from being penetrated, and was thoroughly fortified. Trenches of full profile with shrapnel-proof cover were constructed on the hills between the Tundscha and the Prowadisk near the bridge over the Tundscha. Another line of trenches was dug on a hill some 1000 yards to the front and north of the Prowadisk. The front line of trenches was further strengthened by thirty automatic mines, which were laid in a line from the Tundscha to the Prowadisk. The second line was protected by a wire entanglement which was stretched from the Tundscha to the foot of the hill on which Fort Kojalyk lay. This fort, which was armed with the ordinary field guns, was old and badly concealed from view, lifting up its high walls sharply from the top of the hill. The slopes of the hill were steep, so that there were dead angles at the foot.

"In order to increase the defensive power of this fort, the Turks dammed up the Prowadisk, and caused in front of the fort an inundation which was not fordable. In addition, they provided a wire entanglement. The position which they made by these means was very strong in front and well protected on the flanks. The left flank was protected by trenches dug in the level ground, and the right flank by the neighboring group 'Kurt-Kaja' of the hilly part of this section, which flanked the approaches to Kojalyk.

"The group 'Kurt-Kaja' occupies a massive hill, which rises 300 feet above the valley, and consists of two forts, the old Tasch-Tabia and the new Tasch-Tabia, groups of trenches, and several batteries. The new Fort Tasch-Tabia is a battery in the form of a lunette with brick casemated traverses of the style of the eighties, but without guns. In the interior of the fort there is a large brick barracks. The old fort is a ruined redoubt of the style of the seventies, 1000 yards behind the new fort.

"The strength of this group too lies in the well concealed trenches. The trenches were of the standing type, but cover against shrapnel fire was absolutely lacking.

"Commencing with Fort Tasch-Tabia, the entire northeast front was covered by an unbroken line of wire entanglements. Several trenches had been dug in front of this wire entanglement.

"In the second line of the northerly section of the northeast front, over 3000 yards in rear, lie the two old forts of the seventies, Baschi-Tak-Tabia and Taschlyk-Alty-Tabia. On the rear slopes of the hills on which these forts are situated, temporary magazines had been constructed.

"Near Fort Tasch-Tabia lies Fort Aiwas-Baba, and it lies on the salient angle formed by the lines of the north and east parts of the northeast front.

"The distance of the north section from the city varies between 5500 and 6000 yards. From Fort Aiwas-Baba the line of fortifications runs due south, and gradually approaches the city. A mile is about the shortest distance between any of the forts and the town.

"The east front occupies a line of heights with easy slopes towards the city, but with much steeper slopes in the direction of the attack (25° to 30°). The city's aqueduct passes through the valley in front. As far as the terrain is concerned, this was a very strong position. The hills rose from 300 to 360 feet above the level ground, and afforded an excellent field of view and fire. Dead angles existed only in insignificant numbers. Excellent covered positions were at hand for the artillery. Communication with the rear and the movements of reserves could be carried on completely out of sight of the enemy.

"The disadvantage of this position consisted in the fact that the ridge rises so sharply from the surrounding country that accurate firing by the attacking artillery was much facilitated.

"These heights were very poorly fortified. In the first line there were seven forts, twenty-one batteries, and a limited number of trenches. The names of the forts in succession from the salient angle are: Aiwas-Baba, Aidchi-Jolu, Kectanelik, Kuru-Tscheschme, Jildys, Top-Jolu, and Kawkas. In the second line Fort Kaik lay on a hill close to the city. All the forts were antiquated. They had been rebuilt to a certain extent in 1885, but since that time nothing had been done to them. The work on them had gone no further than the construction of brick casemates. Neither the glacis nor the covered way could serve as firing positions, and it was customary to dig trenches in front of these works. In a few cases, breast works of sand-bags were provided on the covered way, but cover against shrapnel was lacking as usual—a failure for which the Turks were severely punished later on. Some of the forts had ditches which were entirely fallen in and were without flank protection, so they did not offer an obstacle proof

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against storming. Fort Aiwas-Baba had no ditch at all, but had an old redoubt, which, however, was not used in the defense. All the forts of the east front had high ramparts over which jutted out the casemated traverses. The average distance between forts was about 1000 yards.

"The batteries were emplaced on the same heights as the forts and lay between them. The positions were not concealed, the batteries being easily visible to the assailants despite all efforts to conceal them from view. Only two batteries—one 6-inch howitzer, newly constructed, and one mortar—were well emplaced in concealed positions.

"Most of the large caliber guns were on coast carriages. The batteries were of provisional construction and were provided with sheet metal or wooden overhead cover which was proof against fragments only.

"As the batteries stood on a high ridge, there was a dead space of more than 2000 yards, so that they could not be used in case of an assault within this territory. Moreover, they were not well adapted for combating the well concealed batteries of the attacking force.

"Magazines of wood lay near the batteries, and the same material was employed in the construction of the magazines for the battery groups. Two thousand yards in rear of Fort Jildys, in a deep ravine, there was an old brick magazine for the batteries of the entire section.

"The intervals between the forts were badly prepared. The trenches on the hills were insufficiently concealed from view, and they had no cover against high angle fire. *Nevertheless in this front too, the trenches were the chief defense, and they showed very great power of resistance against the assaults of the enemy.*

"As the line of forts lay near the city, the Turks fortified advanced positions on a line of hills from Kara-Bair over Masslak, Sapupshilar, Jeski-Kumluk to Demir-Kapu. The distance between these positions and the main position varied from 1000 to 4500 yards. Between Fort Kawkas and Demir-Kapu there were additional fortifications on the Chelwalski hills. These positions were occupied by field fortifications consisting of trenches of various profiles, with communication trenches and earthen huts on the rear slopes, and field batteries.

"Several of the trenches had a half closed trace, but there were no redoubts, despite the fact that the Bulgarian map shows one on the Masslak group.

"The advanced positions were separated from the main position by a valley and a thick wire entanglement which was fatal for the Turks during an assault.

"The northeast front, although strong by nature, was thus badly fortified. The Turks tried to diminish the shortcomings of the main position by constructing the advanced positions; but these latter were poorly fortified, had no cover against artillery fire, and, worst of all, were not far enough to the front, so that the artillery of the attack could fire effectively against both the main and advanced positions at the same time. In some cases, it was possible to support the advanced positions by artillery fire from the main line, but the infantry could not support the advanced troops in moments of necessity, because they were separated from them by the wire entanglement, nor could the advanced troops withdraw when they should.

"Deluded into the belief that he had 'forts'—which, as a matter of fact, were only traps for the enemy's projectiles and graves for the Turkish soldiers—Shukri-Pasha made a poor defense: he made a weak defense of the advanced positions and the main front, as a result of which he met with complete defeat.

"From all points of view, the northwest front was relatively the newest and the strongest front. Its strength lay in the favorable terrain; in the strong and skillfully placed artillery; in the presence of some concrete protection, such as barracks, magazines, etc.; and, chiefly (as was the case throughout the defenses), in the trenches, which were carefully blended with the terrain; and, finally, in a well developed net-work of roads. In addition, the works of the second line and the fortification Chedyrlyk could support an obstinate defense. The weakness of the front was that of the other fronts of the fortress, viz., supporting points that were proof against assault were entirely lacking.

"The west front (Papas-Tepe group) was strong from the point of view of the terrain and also well fortified with field works. The same can be said of the south front. In spite of favorable terrain, the northeast front was weakest, due to numerous tactical and technical errors.

"The principal failure from a technical point of view was the lack of light cover for protection against shrapnel and the incorrect use of wire entanglements."

Of interest are the further remarks of the author concerning the equipment of the fortifications:

Bridge material.—The permanent bridges over the various rivers served as a means of communication between the various fronts of the fortress. The Turks had at their disposal over 118 steel pontons and all the material necessary for building a bridge, but made no use of these supplies. The pontons were not used throughout the siege.

As the communication between the south and east fronts was not good, the commandant could not use his main reserves, which caused the fall of the fortress when the allied troops stormed it.

Means of observation.—A captive balloon of the German type was used with some success for observing the results of fire of the Turkish batteries.

Illumination.—Three searchlights were in use. In the beginning one was placed near "Kasan-Tepe," but later was removed to a position near "Schaitan-Tarla." The second was on the south front, and the third on one of the towers of the mosque Sultan Selim.

Building material.—For obstacles there were barbed wire and metal poles, over eight feet high, and trees suitable for abatis. Sheet metal for cover was on hand and there was an abundant supply of lumber of all kinds. In addition, the commandant had all the resources of the city at his disposal, and could have used the rails of the Sofia-Constantinople line as far as they were within the limits of the fortifications.—*Deutsches Offizierblatt.*

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THE TSCHERNOFF THEORY OF EROSION*

By Captain H. Peloux, of the French Artillery

Authorities agree that the starting point of erosion is "a net-work of fine scorings covering the chamber in the vicinity of the centering cone . .

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* For valuable assistance in the translation, the Editor is indebted to Colonel C. De W. Willcox, Professor, Military Academy, and Captain Earl Mc Farland, Ord. Dept.

. . . The depth and the width of the scorings parallel to the axis of the bore increase continually with the number of shots fired, and their merging one with another forms the new surface of the bore, upon which appear, jutting out, a net-work of little projections that stand as witnesses of the original surface eroded by the gases."[*]

But, however easy it is to understand that the smallest scratch upon the walls of a gun may be rapidly enlarged by the gases, still the cause of the original net-work of fine scorings remains unknown. Despite theoretical and practical investigations carried on in most of the artillery or ordnance services of the world—especially that of the United States—light has not been thrown upon this "positive, but as yet undetermined, factor whose bearing upon the problem of erosion is of prime importance."[†]

The principal hypotheses which have been advanced on this subject are the following:

According to M. Vieille, cementation of the surface of steel by the action of highly heated gases in combination with carbon gives a thin, highly tempered skin which cracks in checkers that are at first regular; then the currents of gas which escape through the clearance between the walls of the bore and the rotating band of the projectile, extend the little cracks in the direction of the axis of the bore. This hypothesis was first set forth by Commandant Vasseur in the *Revue d'Artillerie*,[‡] and then taken up by Lieutenant Commander Yarnell,[§] of the United States Navy, after the theory had appeared to be confirmed by experiments of the Bethlehem Steel Company and by a series of investigations conducted at Indian Head.[||]

For other authorities the principal cause of erosion is the chemical action of the gases on the metal. The author of an anonymous article which appeared in *Streffleurs Militarische Zeitschrift*,[¶] attempts to deduce some general laws from the numerous experiments made in the matter, and he arrives at the following conclusions:

"The gases of combustion are harmful, for the powder is never perfectly pure, and there is always given off coal-gas, hydrogen, and bioxide of nitrogen, which attack steel.[**] . . . . . . There are to be considered as causes of erosion: (1) the gases . . . which attack steel; (2) the solid particles carried along by the gases, which are the result of an incomplete combustion of the charge . . . ; (3) the high temperatures of combustion, which soften the metal, sometimes almost fuse it, and always render it more susceptible to attack by the gases . . ."

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[*] See the article by M. Vieille, entitled *Etudes sur les Phenomenes d'erosion produits par les explosifs* (*Memorial des Poudres et Salpetres*, t. XI, 1901).

[†] It was thus that Abel expressed himself in 1886. See the *Journal of the Iron and Steel Institute*, Vol. XXIX, *The Erosion of Gun Barrels by Powder Products*, p. 471. (The quotation from Abel as given above is through the French. From the original the following is quoted, the clause corresponding to that cited by Captain Peloux being italicized and followed by its rendering in French: "Whatever the action of carbon, manganese, or silicon might be, whatever effect hardness or softness might have, in promoting or retarding erosion by powder-products, and by the passage of the projectile through the bore, it now became evident that some *agency, hitherto unsought for, overpowered them and dominated the results* [*facteur certain mais non encore isole dont l'importance sur l'erosion est capitale*]."—The Editor.)

[‡] See the article, *Etude sur les degradations a l'interieur des bouches a feu*, November, 1907, t. 71, p. 107.

[§] See the article, *Gun Erosion*, in the *Journal of the American Society of Naval Engineers*, May, 1910, No. 2, p. 334.

[||] Yarnell's conclusions were strongly opposed by Professor Alger, in *The United States Naval Institute Proceedings*, September, 1910. In Professor Alger's opinion, the principal factors of erosion are the temperature of combustion, the weight of the powder charge, and the time during which the hot gases act on the walls of the bore.

[¶] See the issue for January, 1912, p. 168, the article entitled *Ueber die Erosion und die Brauchbarkeitsgrenze der modernen Prazisionsgeschutze*.

[**] Complete combustion of the gases of the charge yields water, carbonic acid, carbon monoxide, nitrogen, and, eventually, oxygen. As a matter of fact, there is imcomplete combustion, and there is formed also oxide of nitrogen. See the article by Captain Bravetta, entitled *L'Erosione delle Artiglierie*, in *Rivista di Artiglieria e Genio*, July-August, 1911, p. 57.

According to Commandant Charbonnier, neither imperfect obturation nor the temperature or chemical composition of the powder gases are causes: rather is the volume of the gases to be likened to a stream constricted in the vicinity of the centering cone, the vortexes of gaseous particles resulting from that constriction being the agents of attack on the walls of the slope," just as there occur at the bends and at the points of change in width of the bed of a watercourse, the eddies and whirlpools that erode and wear away its banks."* There is, then, no erosion, properly speaking; but rather a scraping which shows, on the one hand, the successive circumferential passes of the tool, and, on the other, the cuttings of the same tool in the direction of the axis of the bore. That is what produces the original checkered appearance.

Thus, while the first theories point to a reduction of the *temperature* of the gases and to an improvement of the *obturation*, Commandant Charbonnier's theory leads to a modification of the *design* of the piece: if the behavior of the gases in motion was constant, the solution would consist in giving to the bore the profile of the nozzle of least resistance.

Another hypothesis, based solely on the *physical action of heat*, has been advanced by Professor Tschernoff, of St. Petersburg, in the *Artilleriiskii Journal*.† We will quote the most important passages of his article.

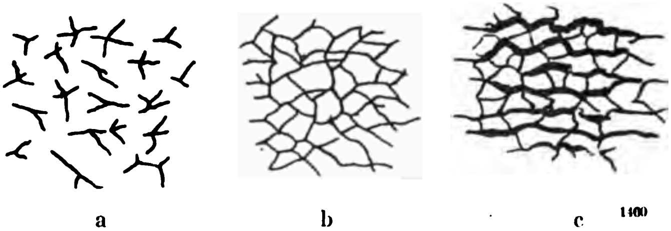

FIG. 1.

THE TSCHERNOFF THEORY OF EROSION

The first evidences of erosion are manifested in the appearance of dull spots upon the brilliant surface of the bore, principally in the upper part of the chamber, in the vicinity of the centering cone and on the cone itself at the origin of the rifling. Examination of gutta-percha impressions shows that these spots are made up of net-works of small cracks, extremely fine and very shallow. As a rule, the meshes of these nets are not closed in the incipient stage (Fig. 1, *a*); but as the firing is continued, the little isolated cracks extend, joining the neighboring ones and forming a net-work of continuous meshes (Fig. 1, *b*). The sizes and shapes of the meshes vary, depending upon the caliber, the length of the bore, the trace of the rifling, the kind of powder, the metal, etc. But in each case and for the same piece, the figure is identical in all parts of the bore showing signs of erosion.

With repeated firing, the little cracks increase in width and depth; but on the centering cone and at the origin of the rifling, this increase is particu-

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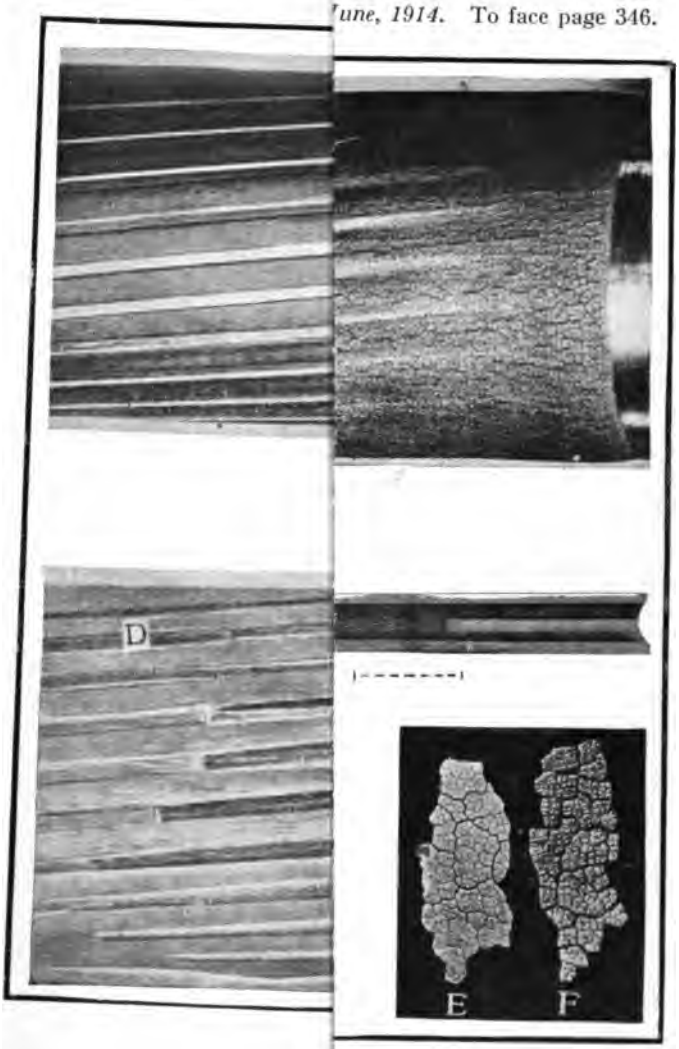
* See the article. *Recherches experimentales et theoriques sur la balistique interieure*, in the *Memorial de l'Artillerie de la Marine*. 1st issue, 1906, p. 31.

† See *Artilleriiskii Journal*, No. 7, 1912. See also, in the same publication, an article by A. Matiounine, *Erosion of Guns*, No. 1, 1910.



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larly noticeable in the cracks parallel to the axis (Fig. 1, *c*): the gases of the charge and the unburned particles of powder penetrate between the projectile and the bore and follow the lines of least resistance, cutting them deeper. If the piece is continued in use, the erosion extends along the bore and reaches a maximum at a certain distance from the origin of the rifling (Fig. 2, C and D), then it diminishes until it almost entirely disappears at the muzzle.* This deepening of the cracks parallel to the axis of the bore clearly indicates mechanical action of the products of combustion . . . . . .

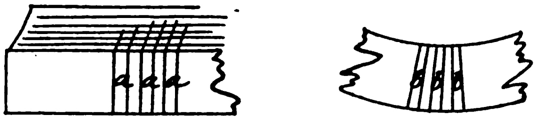

FIG. 3. 1462

On the lands and on the edges of the grooves, transverse cracks or scorings predominate: as soon as a fissure appears in a plane at right angles to the axis of the bore, the rotating band of the projectile enters it, tears away particles of steel, and enlarges it at each shot. The erosion sometimes proceeds so far as to remove the lands completely, or even to make hollows where the lands were (Fig. 2, D).†

Let us now investigate the conditions surrounding the walls of the bore at the moment of firing.

The inflammation of the powder charge creates an igneous fluid, of extremely high temperature and under a pressure of several thousand atmospheres. The metal of the walls is therefore highly heated, but to a very limited depth, on account of the short time of exposure to the heat, and can be expressed in tenths or hundredths of a millimeter. After discharge, conditions are reversed and the heated portion of the metal undergoes a rapid loss of heat, owing to the conduction of the rest of the metal of the tube.

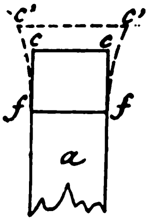

FIG. 4. 1463

Assume, Fig. 3, *aa*, *bb*, a series of wedge-shaped units of mass, limited, in one direction, by planes perpendicular to the axis of the piece, and, in the other direction, by axial planes. Then let us take an *isolated* one of these units (Fig. 4) and see what changes of form it will undergo as a result of changes of temperature.

If *cc* is the exterior surface of the unit at rest, the rapid and extreme heating caused by the explosion of the charge will so expand the unit as to give it a form such as *fc'c'f*. Then, the application of heat ceasing, the wall $c'c'$ will rapidly cool; and, since the mass of the heated skin and the quantity of heat absorbed are negligible in comparison with the mass and the calorific capacity of the entire unit of mass, it can be assumed that the temperature of the unit, at the end of the period of cooling, is normal; that is to say, the body $fc'c'f$ entirely resumes the form $fccf$.

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* Fig. 2, A and B, represents the longitudinal sections of two Russian 3-inch pieces which had been fired about 3000 times.

† This phenomenon is extremely rare; at least, in French guns. It has, however, been observed sometimes.—*Note by Captain Peloux.*

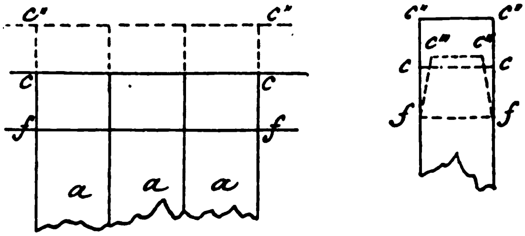

FIG. 5. 1464

But the case is different when it is a question, not of an isolated unit, but of a unit in a group *aa*, Fig. 5. Such a unit of mass can expand freely in but one direction, and the expanded volume will be $fc''c''f$. Then, upon cooling, the surface layer will not resume its original form, for the heating has had the effect of *compressing* and *elongating* the outer section of the unit; the form will be $fc'''\ c'''\ f$, the volume $fc'''\ c'''\ f$ being equal to $fccf$. So the group of units considered will finally appear as in Fig. 7. If the elasticity of the metal is insufficient, the forming of transverse cracks is inevitable.

Let us now see what occurs in the case of a unit of a group *bb*, Fig. 6. The phenomenon is the same, but the pressure to which the expanded end of each unit is subjected will be even greater than in the case first considered, for the length $c''c''$ after expansion is not even equal to, but is shorter than, the length *cc* before expansion. Hence it follows that, after the period of cooling, the breaks between units of mass will be wider than in the case first considered (Fig. 8). There will be, then, on the smooth and cylindrical surface of the bore, a predominance of longitudinal cracks; and this predominance will be all the more emphasized from the fact that the expanded circumference of the bore will be smaller than the unexpanded circumference; that is, from the fact that the diameter of the piece will have been reduced.

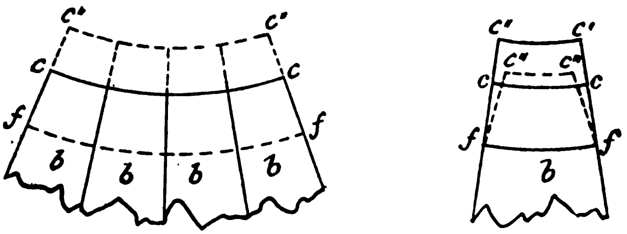

FIG. 6. 1465

The bore of a rifled gun presents exactly the three cases we have just investigated; that is to say, we can consider units of mass grouped along a rectilinear element of the bore, or grouped along a circular cross section, or capable of expanding freely—lands. We have then the series of pnenomena represented by Figs. 4, 5, and 6.

The lands constitute slender and salient ribs, bathed on three sides by the gaseous current; so they are heated much more than the bottom of the grooves, especially on the edges (Fig. 9), where it is evident that a unit, *m*, has twice as much surface exposed to the heat as has either of the units, *m'* or *m''* . . . . The lands will be, therefore, the seat of deep erosions, especially along the edges; and those erosions will be almost wholly transverse, since, the narrower the land, the more closely does the expansion and contraction of the metal, in the transverse direction, approximate the phenomena of the isolated unit.* That is one of the causes of the complete wearing away of the lands, of which Fig. 2, D, gives an example.

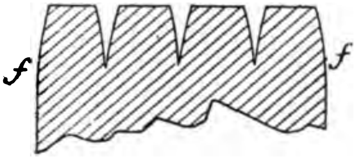

Fig. 7.

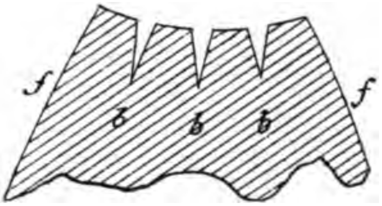

Fig. 8. 1466

(If the foregoing theory is true, similar little cracks ought to occur on the surface of dies used in hot stamping of metals, where the dies are chilled by a current of water between impressions; while the surface of dies used in cold stamping of coins and medals ought to be unaffected. And that is what really happens. Likewise, the surface of a roller, subjected to a high pressure and a great rise of temperature at *m'*, Fig. 10, when in contact with the white-hot body to be rolled, and then chilled by a stream of water at *m'''*, undergoes the same atlernations as a unit mass of the wall of a gun. But neither the die nor the roller is exposed to the dynamic action of the gaseous currents, of the particles of powder, and of the projectile in motion; so the effect upon their surfaces ought to resemble that upon the bore of a gun where the dynamic action is weakest; and, indeed, there is a striking resemblance between E and F, Fig. 2, where E is the full-size reproduction of a portion of the surface of a roller, and F the enlargement, to a scale of about 2¼, of a portion of the bore of the piece shown in C, Fig. 2, the portion being at the origin of the rifling near the end of the cartridge-case, where there is not a sign of wear due to mechanical rubbing.

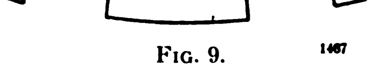

Fig. 9. 1467

Can the part of the bore where the greatest damage will be done be determined? It will not necessarily be where the temperature of the gases is highest, for the heating of the skin of the walls depends upon the velocity of the gaseous current, but indeed in the part corresponding to the maximum value of a complex function of the temperature, density, specific heat, pressure, and velocity of the gases, which would represent the force of transmission of heat to the different points of the walls of the gun.

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* From this point of view, it would be advantageous to have broad lands and narrow grooves.—*Note by Professor Tschernoff.*

Hence the conclusions, which the author expresses thus:)*

The theory which attributes gun erosion principally to the mechanical action of the gases and projectile cannot be maintained; while, as for the chemical action of the gases, that is wholly negligible with modern powders, which have no constituent harmful to steel: the fundamental cause of the whole evil is in the excessively high temperature of combustion of the powder, *which it is absolutely essential to lower.* The chemists' efforts should all be directed toward discovering a powder which, without loss of ballistic qualities, would burn at a temperature *not higher, if possible, than 1000° C.*

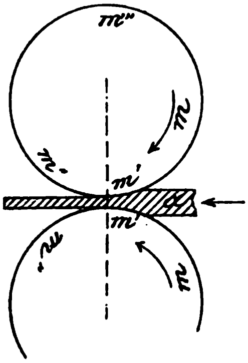

FIG. 10. 1468

On the other hand, the work of the metallurgists is to find a metal which, without sacrifice of mechanical qualities, would possess great *plasticity* and great *tenacity*, so that the alternations of expansion and contraction would cause no crack.†

And, finally, since the formation of cracks is an incident of expansion, it seems desirable that the inner tube of the gun shall have a *very small coefficient of expansion*—small enough, at any rate, for the maximum expansion caused by combustion of the charge to remain within the elastic limit of the metal.

There are, then, three remedies for gun erosion; the first is the most important, and recourse to it is absolutely imperative.

I. TSCHERNOFF

Professor Tschernoff's theory arrests attention; but does it definitely explain the way in which erosion takes place?

It would seem that erosion is a very complex phenomenon, the various contributory causes of which defy strict classification. Numerous experiments have, indeed, proved that it is advantageous to reduce the temperature of combustion of the gases;[*] and others seem to emphasize the importance of obturation;[†] while success in reducing erosion very noticeably has been achieved by adding to the powder substances that will fix the nitric acid yielded by the bioxide of nitrogen. So it is not to be expected that a single theory, however probable, will lead investigators from fields of exploration where much undoubtedly still remains to be gleaned—*Revue d'Artillerie.*

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* These parenthetical paragraphs are by Captain Peloux.

† The result of numerous experiments in Russia, which indicate that tubes of hard steel wear out much more quickly than tubes of soft steel, would seem to support the Tschernoff theory. See, in this connection, Captain Bravetta's article, *L'Erosione delle artiglierie*, in the *Rivista di Artiglieria e Genio* for July-August, 1911, p. 29.—*Note by Captain Peloux.*

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WARSHIP CONSTRUCTION IN 1913

We herewith give our usual pages dealing with naval construction during the past year. So far as the design of capital ships is concerned, the most noteworthy feature is the very general adoption of five turrets in the center line, the only exception to this arrangement being found in the Spanish ship *Alfonso XIII.* We may note also in ships laid down the gradual substitution of 15-inch guns for 14-inch or thereabouts; the appearance of the quadruple turret in French ships; the abandonment of the triple turret in the Italian ships, and its increased application in the United States. The general tendency is towards an increase of the caliber of guns and the consequent reduction of the number of turrets.

Feeling with regard to speed has apparently changed, and there is a return to 21 knots.

We do not give details of thickness of armor in our tables, as nowadays much uncertainty exists as to the precise number of inches considered necessary for protection. It is, however, impossible to avoid noticing that, with a few exceptions, the tendency is towards considerably increased protection, the lead in this direction being taken by Germany.

The really outstanding feature of 1913 as regards ships laid down is the definite adoption of quadruple turrets by the French navy. Although this example has not been followed, there are not wanting indications that the future trend of battleship design will be towards the concentration of the largest possible number of guns in the smallest possible number of turrets.

In the small ships laid down it is interesting to note a considerable extension of the application of thin side armor to what were previously known as protected cruisers. To assign a date for the initiation of this idea is somewhat difficult, as it is very many years ago that Yarrow's first applied it to the Japanese torpedoboat *Kotaka*, and later followed it up with some armored destroyers for the Argentine navy. A similar idea was subsequently prevalent in France, where torpedoboats on similar lines were produced, but not persisted in. Vickers, Limited, in H.M. scout *Forward* can claim to have reinitiated the idea in connection with small cruisers. The design of the *Forward* was followed by the Austrians in the *Admiral Spaun*, launched in 1909, and subsequently by the Germans in the "Breslau" class. The past year, however, sees a very considerable extension of the idea, though the thickness of armor which can be carried is so slight that its efficacy against the 4-inch guns now universally mounted in destroyers may be questioned.

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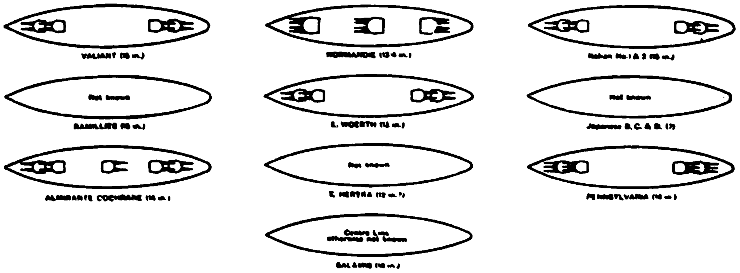
[*] Nitroglycerin powders, especially balistite and cordite, give temperatures considerably higher than nitrocellulose powders. In order to lower the temperature of the gases of combustion, effort has been made to reduce the quantity of nitroglycerin in the explosive, or to add substances that will result in chemical combinations absorptive of heat, such as carbon, vaselin, nitroguanidin, cyanamide, etc. See page 63 of the article by Captain Bravetta, previously cited.

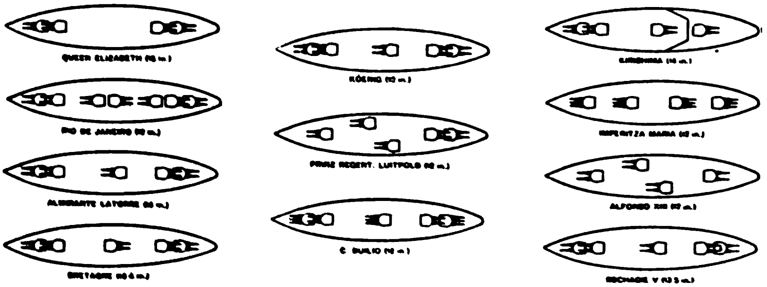
[†] See *Revue d'Artillerie*, September, 1912, t. 80, p. 475.

Not impossibly it may be ascertained eventually that a slight armor defense is worse than no protection at all.

In this connection mention may be made of the fact that the American idea of "everything or nothing" embodied in the armor scheme of the latest United States Dreadnoughts has made comparatively little progress in European designs, in which there is an increasing tendency to give a certain amount of protection to the secondary armament. The protection afforded is, of course, totally useless against the big guns now mounted, no matter what the range, and probably no matter what the angle. Medium armor is never likely to do anything except ensure the bursting of shells which otherwise might pass through and burst outside the ship. Although, therefore, the American idea has not yet been copied to any extent, it may be taken as certain that it will eventually become a feature of all big warship design.



Deck Plans of Capital Ships Laid Down 1469



Deck Plans of Capital Ships Launched in 1913 1470

In engineering matters an increase in the number of turbine types and a decrease in the number of boiler types is to be noted. It must be now some years since at least two leading Powers were reported to be building "motor battleships," but, so far as large ships are concerned, there is no indication whatever of the adoption of the internal combustion motor even for auxiliary propulsive purposes. Progress in this direction is, however, to be recorded in destroyers, against which may be set the fact that steam for the surface propulsion of submarines is considerably more in favor now than it was a year ago.

Although the ships have not yet been laid down, it is of interest to record that France has during the past year come into line with England and Germany in projecting small cruisers, which are presumably designed as destroyers of destroyers.

CAPITAL SHIPS LAID DOWN IN 1913

Name.	Date.	Normal Displacement.	Main armament, guns and torpedoes,	H.P.	Speed.	Machinery.	Boilers.
BRITISH—		Tons.			Knots.		
Valiant	January	27,500	8 15in., 12 6in., 5 t.t.	58,000	25	Parsons turbine	Yarrow
Barham	February	27,500	8 15in., 12 6in., 5 t.t.	58,000	25	Parsons turbine	Yarrow
Malaya	October	27,500	8 15in., 12 6in., 5 t.t.	58,000	25	Parsons turbine	Babcock
Ramilies	November	25,750	8 15in., 12 6in., 5 t.t.	31,000	21	—	Babcock
Resolution	November	25,750	8 15in., 12 6in., 5 t.t.	31,000	21	—	Yarrow
CHILE—							
Almirante Cochrane	February	28,000	10 14in., 16 6in., 4 t.t	40,000	23	Turbine	21 Yarrow
DENMARK—							
Niels Juel	November	3,675	2 9.4in., 4 6in., 4 t.t.	5,400	16	(?)	Thornycroft
FRANCE—							
Normandie	May	25,387	12 13.4in., 24 5.5in., 6 t.t.	—	21.5	Parsons turbine	—
Gascoigne	May	25,387	12 13.4in., 24 5.5in., 6 t.t.	—	21.5	Parsons turbine	Normand
Languedoc	November	25,387	12 13.4in., 24 5.5in., 6 t.t.	—	21.5	Schneider-Zoelly	—
Flandres	November	25,387	12 13.4in., 24 5.5in., 6 t.t.	—	21.5	Parsons turbine	Normand
GERMANY—							
E. Wörth	(1913)	28,000	8 15in., 16 6in., 8 t.t.	—	23	Turbine	Schulz-Thy
"T"	July	28,000	8 15in., 16 6in., 8 t.t.	—	23	Turbine	Schulz-Thy
E. Hertha	July	27,400	8 12in., 12 6in., 5 t.t.	—	—	Turbine	Schulz-Thy
GREECE—							
Salamis	(1913)	19,500	8 14in., 12 6in.	40,000	24	A.E.G. Curtis t.	—
ITALY—							
No. 1	(1913)	30,000	8 15in., 16 6in.	(?)	25	Parsons turbine	—
No. 2	(1913)	30,000	8 15in., 16 6in.	(?)	25	Parsons turbine	—

CAPITAL SHIPS LAID DOWN IN 1913 (Continued)

Name.	Date.	Normal Displacement.	Main armament, guns and torpedoes.	H.P.	Speed.	Machinery.	Boilers.
JAPAN—		Tons.			Knots.		
B	(1913)	30,000	(?)	—	—	—	Miyabara
C	(1913)	30,000	(?)	—	—	—	Miyabara
D	(1913)	30,000	(?)	—	—	—	Miyabara
NORWAY—							
Bjorgvin	(1913)	4,900	2 9.5in., 4 6in., 2 t.t.	—	15	—	Yarrow
Nidaros	(1913)	4,900	2 9.5in., 4 6in., 2 t.t.	—	15	—	Yarrow
U.S.A.—							
Pennsylvania	July	31,400	12 14in., 22 5in., 4 t.t.	31,000	21	Curtis turbine	—

NOTE.—As usual, there is in this table a good deal of insufficient information; but it is considered better to confine data to what can be definitely authenticated than to include details concerning which verification from the right quarter connot be secured. It will be noted that one or two ships long since "laid down" by report in the daily Press do not appear in this list. Such omissions are due to the fact that we have endeavored to discriminate between an order to lay down and the actual performance. Quite a number of ships "projected" during the past year have never been laid down, and a fair proportion of them probably never will be.

CAPITAL SHIPS LAUNCHED IN 1913

BRITISH—							
Queen Elizabeth	October	27,500	8 15in., 12 6in., 5 t.t.	58,000	25	Parsons turbine	Babcock
Warspite	November	27,500	8 15in., 12 6in., 5 t.t.	58,000	25	Parsons turbine	Yarrow
Benbow	November	25,000	10 13.5in., 12 6in., 5 t.t.	30,000	21	Parsons turbine	Babcock
Emperor of India (ex Delhi)	November	25,000	10 13.5in., 12 6in., 5 t.t.	30,000	21	Parsons turbine	Yarrow
Tiger	December	28,000	8 13.5in., 12 6in., 3 t.t.	75,000	28	Brown-Curtis t.	Babcock
BRAZIL—							
Rio de Janeiro	January	27,500	14 12in., 20 6in., 3 t.t.	45,000	22	Parsons turbine	Babcock

CHILE—							
Almirante Latorre	November	28,000	10 14in., 16 6in., 4 t.t.	40,000	23	Turbine	Yarrow
FRANCE—							
Bretagne	April	23,550	10 13.4in., 22 5.5in., 4 t.t.	29,250	20.5	Parsons turbine	Niclausse
Lorraine	September	23,550	10 13.4in., 22 5.5in., 4 t.t.	29,250	20.5	Parsons turbine	D.T. Guyot
Provence	April	23,550	10 13.4in., 22 5.5in., 4 t.t.	29,250	20.5	Parsons turbine	Belleville
GERMANY—							
Koenig	March	25,500	10 14in., 12 6in., 8 or 6 t.t.	34,000	21.5	Parsons (mod.)	Schulz-Thy
Grosser Kürfurst	May	25,500	10 14in., 12 6in., 8 or 6 t.t.	34,000	21.5	A.E.G. (Curtis)	Schulz-Thy
Markgraf	June	25,500	10 14in., 12 6in., 8 or 6 t.t.	34,000	21.5	Bergmann	Schulz-Thy
Prinz. Reg. Luitpold	February	24,700	10 12in., 14 6in., 5 t.t.	25,000	20	Parsons turbine	Schulz-Thy
Derflinger	July	25,000	8 12in., 12 6in., 5 t.t.	63,000	26.5	Parsons turbine	Schulz-Thy
Lutzow	November	27,400	8 12in., 12 6in., 5 t.t.	(?)80,000	28	Turbine	Schulz-Thy
ITALY—							
C. Duilio	April	22,000	13 12in., 16 6in., 3 t.t.	24,000	22.5	Parsons turbine	Yarrow
A. Doria	March	22,000	13 12in., 16 6in., 3 t.t.	24,000	22.5	Parsons turbine	Yarrow
JAPAN—							
Fu-So	(1913)	30,000	10 14in., 16 6in.	45,000	22.5	Parsons turbine	Miyabara
Haruna	December	27,500	8 14in., 16 6in., 8 t.t.	68,000	27	Parsons&Curtis	Miyabara
Kirishima	December	27,500	8 14in., 16 6in., 8 t.t.	68,000	27	Parsons&Curtis	Miyabara
RUSSIA—							
Imperitza Maria	November	22,500	12 12in., 20 5in., 4 t.t.	25,000	21	Parsons turbine	Yarrow
Ekaterina II	December(?).	22,500	12 12in., 20 5in., 4 t.t.	25,000	21	Parsons turbine	Yarrow
SPAIN—							
Alfonso XIII	May	15,700	8 12in., 20 4in., 3 t.t.	15,500	19.5	Parsons turbine	Yarrow
TURKEY—							
Rechadieh V	September	23,000	10 13.5in., 16 6in., 3 t.t.	20,000	21	Parsons turbine	Babcock

NOTES.—There is some doubt as to whether the Ekaterina II (Russian) has yet been launched. The Rio de Janeiro is reported sold to Turkey. The Latorre has been reported sold to Greece, but this last report has been officially denied.

CAPITAL SHIPS LAID DOWN IN 1913 (Continued)

Name.	Date.	Normal Displacement.	Main armament, guns and torpedoes.	H.P.	Speed.	Machinery.	Boilers.
JAPAN—		Tons.			Knots.		
B	(1913)	30,000	(?)	—	—	—	Miyabara
C	(1913)	30,000	(?)	—	—	—	Miyabara
D	(1913)	30,000	(?)	—	—	—	Miyabara
NORWAY—							
Bjorgvin	(1913)	4,900	2 9.5in., 4 6in., 2 t.t.	—	15	—	Yarrow
Nidaros	(1913)	4,900	2 9.5in., 4 6in., 2 t.t.	—	15	—	Yarrow
U.S.A.—							
Pennsylvania	July	31,400	12 14in., 22 5in., 4 t.t.	31,000	21	Curtis turbine	—

NOTE.—As usual, there is in this table a good deal of insufficient information; but it is considered better to confine data to what can be definitely authenticated than to include details concerning which verification from the right quarter connot be secured. It will be noted that one or two ships long since "laid down" by report in the daily Press do not appear in this list. Such omissions are due to the fact that we have endeavored to discriminate between an order to lay down and the actual performance. Quite a number of ships "projected" during the past year have never been laid down, and a fair proportion of them probably never will be.

CAPITAL SHIPS LAUNCHED IN 1913

Name.	Date.	Normal Displacement.	Main armament, guns and torpedoes.	H.P.	Speed.	Machinery.	Boilers.
BRITISH—							
Queen Elizabeth	October	27,500	8 15in., 12 6in., 5 t.t.	58,000	25	Parsons turbine	Babcock
Warspite	November	27,500	8 15in., 12 6in., 5 t.t.	58,000	25	Parsons turbine	Yarrow
Benbow	November	25,000	10 13.5in., 12 6in., 5 t.t.	30,000	21	Parsons turbine	Babcock
Emperor of India (ex Delhi)	November	25,000	10 13.5in., 12 6in., 5 t.t.	30,000	21	Parsons turbine	Yarrow
Tiger	December	28,000	8 13.5in., 12 6in., 3 t.t.	75,000	28	Brown-Curtis t.	Babcock
BRAZIL—							
Rio de Janeiro	January	27,500	14 12in., 20 6in., 3 t.t.	45,000	22	Parsons turbine	Babcock

CHILE—							
Almirante Latorre	November	28,000	10 14in., 16 6in., 4 t.t.	40,000	23	Turbine	Yarrow
FRANCE—							
Bretagne	April	23,550	10 13.4in., 22 5.5in., 4 t.t.	29,250	20.5	Parsons turbine	Niclausse
Lorraine	September	23,550	10 13.4in., 22 5.5in., 4 t.t.	29,250	20.5	Parsons turbine	D.T. Guyot
Provence	April	23,550	10 13.4in., 22 5.5in., 4 t.t.	29,250	20.5	Parsons turbine	Belleville
GERMANY—							
Koenig	March	25,500	10 14in., 12 6in., 8 or 6 t.t.	34,000	21.5	Parsons (mod.)	Schulz-Thy
Grosser Kürfurst	May	25,500	10 14in., 12 6in., 8 or 6 t.t.	34,000	21.5	A.E.G. (Curtis)	Schulz-Thy
Markgraf	June	25,500	10 14in., 12 6in., 8 or 6 t.t.	34,000	21.5	Bergmann	Schulz-Thy
Prinz. Reg. Luitpold	February	24,700	10 12in., 14 6in., 5 t.t.	25,000	20	Parsons turbine	Schulz-Thy
Derflinger	July	25,000	8 12in., 12 6in., 5 t.t.	63,000	26.5	Parsons turbine	Schulz-Thy
Lutzow	November	27,400	8 12in., 12 6in., 5 t.t.	(?)80,000	28	Turbine	Schulz-Thy
ITALY—							
C. Duilio	April	22,000	13 12in., 16 6in., 3 t.t.	24,000	22.5	Parsons turbine	Yarrow
A. Doria	March	22,000	13 12in., 16 6in., 3 t.t.	24,000	22.5	Parsons turbine	Yarrow
JAPAN—							
Fu-So	(1913)	30,000	10 14in., 16 6in.	45,000	22.5	Parsons turbine	Miyabara
Haruna	December	27,500	8 14in., 16 6in., 8 t.t.	68,000	27	Parsons&Curtis	Miyabara
Kirishima	December	27,500	8 14in., 16 6in., 8 t.t.	68,000	27	Parsons&Curtis	Miyabara
RUSSIA—							
Imperitza Maria	November	22,500	12 12in., 20 5in., 4 t.t.	25,000	21	Parsons turbine	Yarrow
Ekaterina II	December(?).	22,500	12 12in., 20 5in., 4 t.t.	25,000	21	Parsons turbine	Yarrow
SPAIN—							
Alfonso XIII	May	15,700	8 12in., 20 4in., 3 t.t.	15,500	19.5	Parsons turbine	Yarrow
TURKEY—							
Rechadieh V	September	23,000	10 13.5in., 16 6in., 3 t.t.	20,000	21	Parsons turbine	Babcock

NOTES.—There is some doubt as to whether the Ekaterina II (Russian) has yet been launched. The Rio de Janeiro is reported sold to Turkey. The Latorre has been reported sold to Greece, but this last report has been officially denied.

Small Ships Launched in 1913

Name.	Date.	Normal Displacement.	Main armament, guns and torpedoes.	H.P.	Speed.	Machinery.	Boilers.
British—		Tons.			Knots.		
Nottingham	April	5400	9 6in., 2 t.t.	22,000	24.75	Parsons turbine	Yarrow
Birmingham	May	5400	9 6in., 2 t.t.	22,000	24.75	Parsons turbine	Yarrow
Lowestoft	May	5400	9 6in., 2 t.t.	22,000	24.75	Parsons turbine	Yarrow
Arethusa	(1913)	3700	2 6in., 6 4in., 4 t.t.	40,000	30	Brown-Curtis t.	Yarrow
Aurora	September	3700	2 6in., 6 4in., 4 t.t.	40,000	30	Brown-Curtis t.	Yarrow
Undaunted	(1913)	3700	2 6in., 6 4in., 4 t.t.	40,000	30	Brown-Curtis t.	Yarrow
Austria—							
Novara	February	3500	9 4in., 4 t.t.	25,000	27	A.E.G. (Curtis) t.	Yarrow
Minelayer N.	(1913)	1000	Small	—	—	Turbine	—
Brazil—							
Javary	(1913)	1200	2 6in., 2 4.7in.	—	11.5	Reciprocating	Yarrow
Solimoes	(1913)	1200	2 6in., 2 4.7in.	—	11.5	Reciprocating	Yarrow
Madeira	(1913)	1200	2 6in., 2 4.7in.	—	11.5	Reciprocating	Yarrow
France—							
Pluton	(1911)	566	1 3in.	6,000	20	—	—
Germany—							
Grandenz	October	4900	12 4.1in., 2 t.t.	25,500	28	Turbine	Schulz T.

Small Ships Laid Down in 1913

British—		Tons.			Knots.		
Galatea	January	3520	2 6in., 6 4in., 4 t.t.	30,000	30	Parsons turbine	Yarrow
Inconstant	March	3520	2 6in., 6 4in., 4 t.t.	30,000	30	Parsons turbine	Yarrow
Royalist	March	3520	2 6in., 6 4in., 4 t.t.	30,000	30	Parsons turbine	Yarrow

Penelope	February	3520	2 6in., 6 4in., 4 t.t.	30,000	30	Parsons turbine	Yarrow
Phaeton	March	3520	2 6in., 6 4in., 4 t.t.	30,000	30	—	—
Cordelia	July	?	2 6in., 6 4in., 4 t.t.	?	—	—	—
CHINA—							
No. 1	(1913)	?	10 4in., 2 t.t.	30,000	32	Parsons turbine	Yarrow
No. 2	August	?	10 4in., 2 t.t.	30,000	32	Parsons turbine	Yarrow
No. 3	August	?	10 4in., 2 t.t.	30,000	32	Parsons turbine	Yarrow
No. 4	(1913)	—	10 4in., 2 t.t.	30,000	32	Parsons turbine	Yarrow
GERMANY—							
E. Gefion	(1913) spring	?	?	—	28	Turbine	Schulz T.
E. Hela	(1913) spring	?	?	—	28	Turbine	Schulz T.
"C"	October	?	?	?	?	—	—
ITALY—							
Basilicata	(1913)	2560	6 6in.	4000	16.5	—	—
Campania	(1913)	2560	6 6in.	4000	16.5	—	—
Sebastiano-Cabot	(1913)	810	6 12-pdrs.	2000	13	—	—
RUSSIA—							
Swietlana	(1913)	6750	12 6in.	—	—	—	—
Greig	(1913)	6750	12 6in.	—	—	—	—
Bootakoff	(1913)	6750	12 6in.	—	—	—	—
Spiridoff	(1913)	6750	12 6in.	—	—	—	—
M. Amursky	February	4500	8 5in., 2 t.t.	27,400	27½	"Schichau" t.	—
Nevelskoy	February	4500	8 5in., 2 t.t.	27,400	27½	"Schichau" t.	—
Ad. Lazareff	November	6750	12 6in.	—	30	—	—
Ad. Nakimoff	November	6750	12 6in.	—	30	—	—

NOTE.—It is uncertain whether the whole of the Chinese cruisers have actually been laid down.

SMALL SHIPS LAUNCHED IN 1913

Name.	Date.	Normal Displacement.	Main armament, guns and torpedoes.	H.P.	Speed.	Machinery.	Boilers.
BRITISH—		Tons.			Knots.		
Nottingham	April	5400	9 6in., 2 t.t.	22,000	24.75	Parsons turbine	Yarrow
Birmingham	May	5400	9 6in., 2 t.t.	22,000	24.75	Parsons turbine	Yarrow
Lowestoft	May	5400	9 6in., 2 t.t.	22,000	24.75	Parsons turbine	Yarrow
Arethusa	(1913)	3700	2 6in., 6 4in., 4 t.t.	40,000	30	Brown-Curtis t.	Yarrow
Aurora	September	3700	2 6in., 6 4in., 4 t.t.	40,000	30	Brown-Curtis t.	Yarrow
Undaunted	(1913)	3700	2 6in., 6 4in., 4 t.t.	40,000	30	Brown-Curtis t.	Yarrow
AUSTRIA—							
Novara	February	3500	9 4in., 4 t.t.	25,000	27	A.E.G. (Curtis) t.	Yarrow
Minelayer N.	(1913)	1000	Small	—	—	Turbine	—
BRAZIL—							
Javary	(1913)	1200	2 6in., 2 4.7in.	—	11.5	Reciprocating	Yarrow
Solimoes	(1913)	1200	2 6in., 2 4.7in.	—	11.5	Reciprocating	Yarrow
Madeira	(1913)	1200	2 6in., 2 4.7in.	—	11.5	Reciprocating	Yarrow
FRANCE—							
Pluton	(1911)	566	1 3in.	6,000	20	—	—
GERMANY—							
Grandenz	October	4900	12 4.1in., 2 t.t.	25.500	28	Turbine	Schulz T.

SMALL SHIPS LAID DOWN IN 1913

Name.	Date.	Normal Displacement.	Main armament, guns and torpedoes.	H.P.	Speed.	Machinery.	Boilers.
BRITISH—		Tons.			Knots.		
Galatea	January	3520	2 6in., 6 4in., 4 t.t.	30,000	30	Parsons turbine	Yarrow
Inconstant	March	3520	2 6in., 6 4in., 4 t.t.	30,000	30	Parsons turbine	Yarrow
Royalist	March	3520	2 6in., 6 4in., 4 t.t.	30,000	30	Parsons turbine	Yarrow

Penelope	February	3520	2 6in., 6 4in., 4 t.t.	30,000	30	Parsons turbine	Yarrow
Phaeton	March	3520	2 6in., 6 4in., 4 t.t.	30,000	30	—	—
Cordelia	July	?	2 6in., 6 4in., 4 t.t.	?	—	—	—
CHINA—							
No. 1	(1913)	?	10 4in., 2 t.t.	30,000	32	Parsons turbine	Yarrow
No. 2	August	?	10 4in., 2 t.t.	30,000	32	Parsons turbine	Yarrow
No. 3	August	?	10 4in., 2 t.t.	30,000	32	Parsons turbine	Yarrow
No. 4	(1913)	—	10 4in., 2 t.t.	30,000	32	Parsons turbine	Yarrow
GERMANY—							
E. Gefion	(1913) spring	?	?	—	28	Turbine	Schulz T.
E. Hela	(1913) spring	?	?	—	28	Turbine	Schulz T.
"C"	October	?	?	?	?	—	—
ITALY—							
Basilicata	(1913)	2560	6 6in.	4000	16.5	—	—
Campania	(1913)	2560	6 6in.	4000	16.5	—	—
Sebastiano-Cabot	(1913)	810	6 12-pdrs.	2000	13	—	—
RUSSIA—							
Swietlana	(1913)	6750	12 6in.	—	—	—	—
Greig	(1913)	6750	12 6in.	—	—	—	—
Bootakoff	(1913)	6750	12 6in.	—	—	—	—
Spiridoff	(1913)	6750	12 6in.	—	—	—	—
M. Amursky	February	4500	8 5in., 2 t.t.	27,400	27½	"Schichau" t.	—
Nevelskoy	February	4500	8 5in., 2 t.t.	27,400	27½	"Schichau" t.	—
Ad. Lazareff	November	6750	12 6in.	—	30	—	—
Ad. Nakimoff	November	6750	12 6in.	—	30	—	—

NOTE.—It is uncertain whether the whole of the Chinese cruisers have actually been laid down.

Another incident of 1913 is the death of General Cuniberti, the famous Italian naval architect, to whom belongs the credit of the initiation of the Dreadnought idea. At the time of his death General Cuniberti was understood to be working on the design of a submarine Dreadnought in which torpedo tubes replaced big guns of ordinary Dreadnoughts.

For 1914 the adoption of the 15-inch gun is likely to be nearly universal. It appears to be the general opinion that although the torpedo is now a serious rival to the gun in range, it must ever be handicapped by the fact that it is necessarily immeasurably slower. The root idea of the monster gun appears to be the hurling of an explosive charge of the greatest possible destructive power. So far as penetration is concerned a 12-inch gun should be equal to all modern requirements. The gun may definitely be described as having beaten the armor plate. Along these lines it is by no means impossible that 1914 will see ships designed to carry 16-inch guns with a larger caliber still as the probability of the immediate future.—*The Engineer.*

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INTERIOR PROTECTION AGAINST TORPEDOES AND MINES

Because of the striking lessons furnished by the Russo-Japanese war, and because of recent advance in the automobile torpedo, as well as of more extensive use of the submarine mine, all navies have been striving to improve upon the interior protection of ships against torpedoes and mines. The means to the one end adopted in the various countries, differ, and it will be interesting to investigate them.

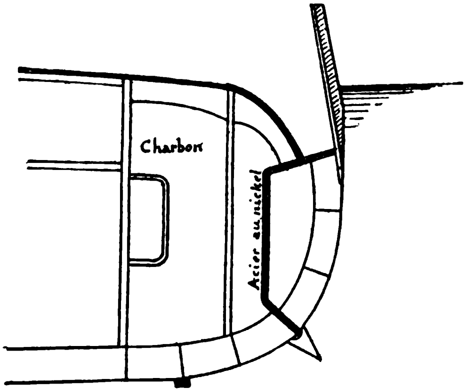

FIG. 1.

Underwater caisson of the *Danton* class.

On the English battleships of the *Orion* and *King George V* types, a longitudinal bulkhead runs, close to the ship's side, along the magazines and engine room, very much like the underwater caisson of our *Danton* class. This bulkhead is made up of two thicknesses of sheet steel of high resistance, of a total thickness of two inches; but, unlike the practice in the case of our *Danton* class, where the caisson is continuous, the bulkhead of the *Orion* classes is interrupted abreast the stoke-holes, where it is continued by only a simple water-tight bulkhead twenty feet distant from the ship's skin, the space between the skin and the bulkhead being occupied by the coal bunkers. The cause of this arrangement is the current opinion that coal constitutes an effective protection, a ten-foot layer being the equivalent of one inch of steel.

On the cruisers of the *Lion* class, the boilers being in much greater number, the stoke-holes have had to be made wider, the run-ways are as long as fifty feet, and the longitudinal bulkhead is continuous from end to end, though its thickness is decreased from two inches to one inch abreast the coal bunkers.

These general arrangements for protection are common to all English shipyards. So the Japanese cruisers of the *Kongo* class (27,000 tons), under construction [October, 1913] in the Vickers yards, have been given a similar longitudinal protection, with an addition of an armored covering, one and a quarter inch thick, in the vicinity of the bunkers—an arrangement that is seen also on the Argentine battleships *Moreno* and *Rivadavia* under construction [October, 1913] in the United States.

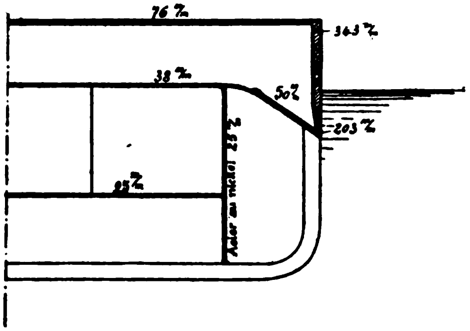

FIG. 2.

Underwater protection of the *Nevada* and *Oklahoma*.

The main section of the Chilian battleship under construction [October, 1913] at the Armstrong yards has been determined by the same desire; but it merits special attention because of the fact that, in order to gain space, the armored bulkhead does not extend all the way to the top, armor protection for the upper part being obtained by means of an armored portion of the second orlop deck.

On the recent American battleships, the *Nevada* and the *Oklahoma*, underwater protection is afforded by a longitudinal bulkhead one inch thick, located sixteen feet from the skin, and completed at the bottom by a horizontal flooring one inch thick also, as on the Argentine ships *Moreno* and *Rivadavia*.

On the large German cruisers of the *Seydlitz* class, the armored bulkhead is vertical and varies in thickness from 1.18 to 1.97 inches, the greatest thickness being abreast the magazines. Located thirteen feet from the skin, this bulkhead runs from the forward turret to the aft turret, having its ends against armored athwartship bulkheads .79 inches thick, and extends above the protected deck to the gun deck. It is almost the same arrangement as that used on the *Kaiser*.

Special mention is due the Russian *Impératrice Marie* class, in which protection against torpedoes is afforded only by watertight subdivisions, or compartments.

In order to protect themselves against flooding as a result of a breach in their bottoms and to avoid the inconveniences of an exaggerated roll, the holds of the new Russian battleships have only athwartship compartments, without middle bulkheads, which occur only in the (otherwise too spacious) engine and boiler rooms, and there are limited to the minimum requirement.

Heretofore, in France, we have favored the armored bulkhead near the ship's side, and it is from that that has developed the caissons for longitudinal protection provided in the bottoms of our *Danton* class.

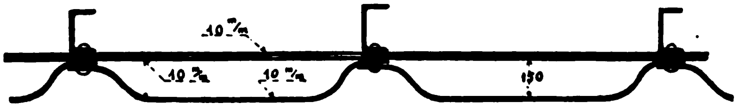

FIG. 3. 1473

Elastic bulkhead of the *Flandre* and *Bretagne* classes.

Are those arrangements really efficacious? It would seem that for the present one may not be at all sure of it. Experiments made in France (Brest and Lorient, *Henri IV* and *Danton* caissons) as well as abroad (Chatham, England, 1910; Bremerton range, United States, 1911-12) have left the matter in considerable doubt. It seems, however, that our recent arrangement, the vertical armored bulkhead, called "elastic bulkhead," ought to give the best result in all respects. This bulkhead, with which our recent ships, *Bretagne*, *Flandre*, etc., are provided, is made up of three thicknesses of sheet steel, about .4-inch thick each, of which two are joined, while the third forms, between uprights, cells of 7.8-inch* thickness, as illustrated in Fig. 3. The most recent experiments in this matter have demonstrated that the foregoing arrangement is clearly more efficacious than the arrangement of three thicknesses of sheets of like thickness superposed one upon another, and more efficacious also than the protective caisson of the *Danton* class.

A last system, however, has just been extolled as especially efficacious and is being very generally studied. It is the arrangement originated by Mr. Wotherspoon, which has been employed in the case of the *North Carolina* and the recent American battleships, including the *Pennsylvania*.

Mr. Wotherspoon's plan is to introduce compressed air in order to stop the flow of water into a damaged compartment. The plan assumes that all the bulkheads are perfectly watertight, and that is the only weak point that can be found in it. In order to diminish the pressure on the bulkheads, compressed air of less pressure is introduced in the compartment which immediately surrounds the damaged one; and a third compartment, which covers the two others, receives air at a pressure equal to that which the watertight bulkheads can withstand. In the American experiments the air pressure varied, in this way, from four to fourteen pounds per square inch, no bulkhead being subjected thereby to excessive pressure.

In order to gain entrance to the damaged compartment, one passes from one compartment to another by means of a series of locks similar to our ordinary man-holes. It would seem, therefore, easy to construct the compartment system of large ships to satisfy those desiderata—all the more, since Mr. Wotherspoon uses for the introduction of the compressed air, the ventilating pipe system already installed for the conveyance of fresh air to the compartments.

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* The text reads 200 mm.—Tr.

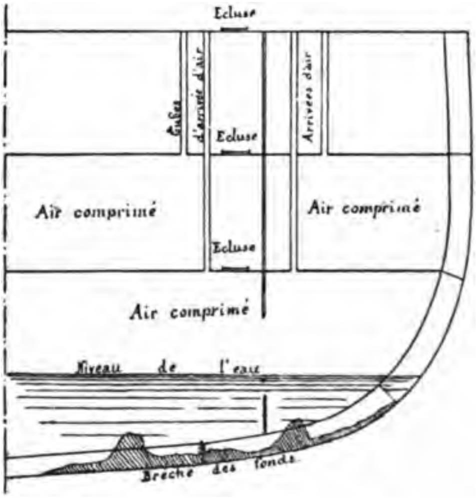

FIG. 4. 1474

The Wotherspoon system of underwater protection by means of compressed air.

The advantages of the American system are readily seen; for, aside from possible protection against inflow of water, it makes it easy to test the compartment system of a ship for watertightness—a test which up to now has never been made in practice. Furthermore, the new installation will permit rapid fighting of fire in a compartment by means of introducing into it, instead of compressed air, an extinguishing gas, such as carbonic acid.

—*Le Yacht* (Paris).

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THE FRENCH MINE LAYERS *CERBERE* AND *PLUTON*

The French naval authorities have, like those of other nations, been devoting a good deal of attention to the question of mine laying. It has been realized by most nations that the lessons taught by the war between Japan and Russia pointed to the necessity of giving this matter a more important position in the general scheme of things than it had held up till then. In France it was by no means at first decided to have special vessels for the purpose. In 1909 some destroyers of the "Cassini" class were altered so as to be used as mine layers, and two years later four 300-ton destroyers were similarly converted. The outcome of the investigations and experiments carried out with these vessels was that the authorities decided that really satisfactory results could only be assured if vessels specially designed for the purpose were employed. Accordingly, two boats, the *Cerbère* and *Pluton*, were ordered. Both these vessels are now in commission.

The following are the leading particulars of the *Cerbère:*

Displacement fully loaded	594.00 tons
Displacement on trials	541.00 tons
Length overall	199 ft. 5 in.
Length between perpendiculars	193 ft. 7 in.
Breadth	27 ft. 3 in.
Depth	14 ft. 2 in.
Draught astern	10 ft. 8 in.

The general arrangement will be apparent from the drawings opposite this page. The hull is divided into ten watertight compartments by transverse bulkheads. It will be noticed, as something out of the ordinary, that the officers' quarters are arranged forward, some of the crew being accommodated aft. The object of the designer has been to disguise as much as possible the nature of the craft, and it is thought that if the one gun carried be covered up the vessel might well be taken for a steam trawler.

The boat is propelled by two sets of three-cylinder triple-expansion engines having diameters of 19 inches, 29 inches, and 48 inches respectively, with a stroke of 23 inches. The propellers are of bronze and 8 ft. 3 inches in diameter. Steam is supplied to both the main engines and auxiliaries by two du Temple water-tube boilers, having a grate area of 151 square feet and a heating surface of 5647 square feet. With steam at 256 lb. pressure the engines are designed to develop 6000 indicated horse-power. The forced draught is produced by two Rateau fans driven by high-speed reciprocating engines. There is a steam-driven dynamo designed for an output of 4 kilowatts at 80 volts, and a Thirion pump for dealing with 15 tons of water per minute.

The ordinary coal bunkers have been worked on both sides of the boiler-rooms, and there are additional bunkers on both sides of the engines. Under ordinary conditions the vessel will carry 145 tons of coal, but in case of necessity she can take just over 180 tons.

The official figures of the results of the trials of the *Cerbère* are as follows:

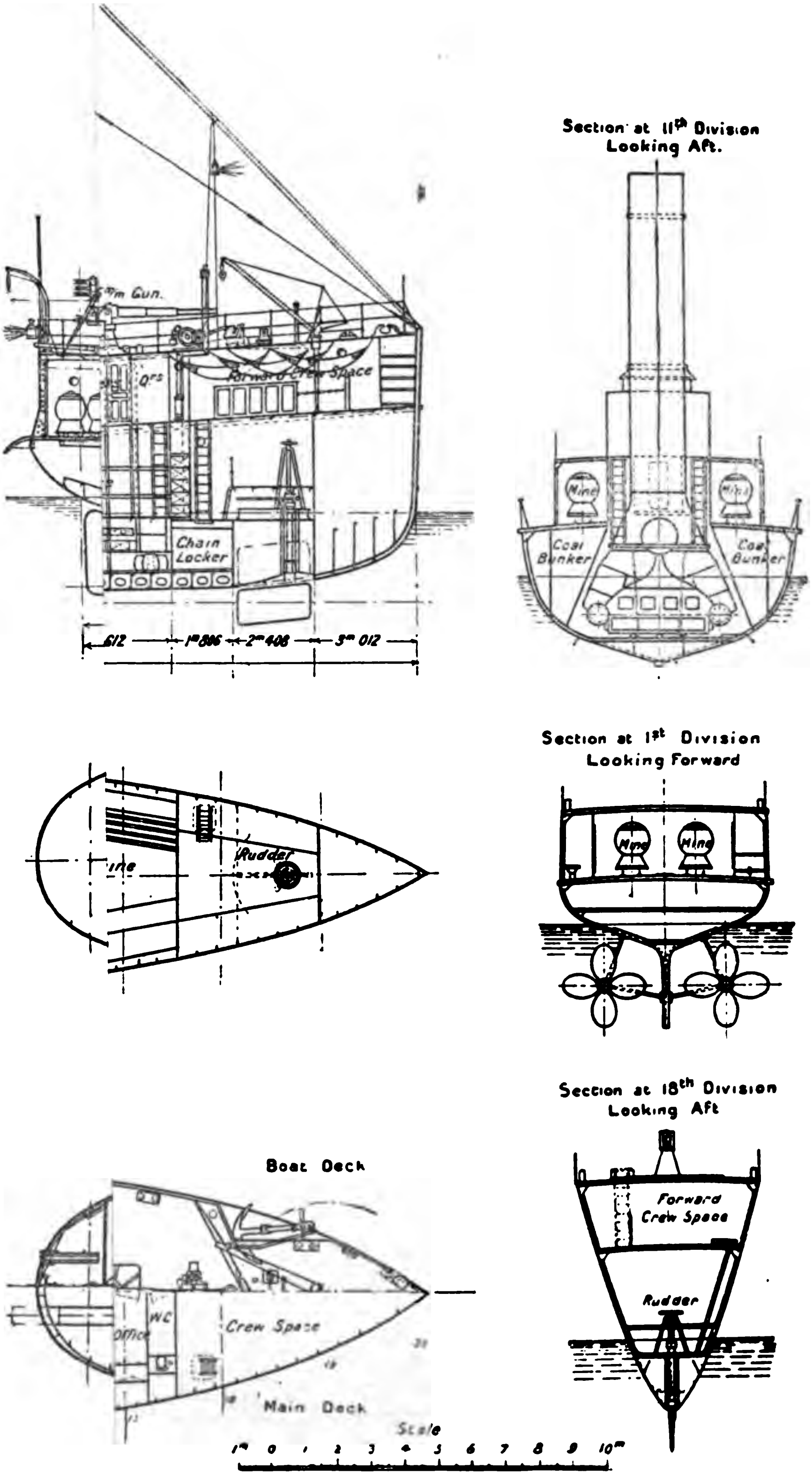
Four Hours' Trial at Full Power

Mean speed	20 knots
Best run on measured mile	21.695 knots
Coal consumption, contract per hour	81 lb. per sq. ft. of grate area
Coal consumption, actual on trial per hour	71 lb. per sq. ft. of grate area
Coal consumption per I.H.P. per hour	1.8 lb.
Revolutions of engines	278.10

Eight Hours' Trial at 16 knots

Mean speed	16.45 knots
Coal consumption, contract per hour	21 lb. per sq. ft. of grate area
Coal consumption, actual on trial per hour	17 lb. per sq. ft. of grate area
Coal consumption per I.H.P. per hour	1.2 lb.
Number of revolutions	202.5

It will be noticed that the vessel is provided with rudders fore and aft. This was [illegible] the experiment[illegible] other vessels, before the desi[illegible] out, so as to [illegible] the requisite control over th[illegible] the mines in [illegible] the predetermined position [illegible] surface of [illegible] feet and the aft rud[illegible]


m/m Gun.
Qrs
Forward Crew Space
Chain Locker
.612
1m 806
2m 408
3m 012
Section at 11th Division
Looking Aft.
Mine
Mine
Coal Bunker
Coal Bunker
Rudder
Section at 1st Division
Looking Forward
Mine
Mine
Boat Deck
WC
Office
Crew Space
Main Deck
Section at 18th Division
Looking Aft
Forward Crew Space
Rudder
Scale
1m 0 1 2 3 4 5 6 7 8 9 10m

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1476

The armament consists of one 3-pounder gun carried forward, and 140 submarine mines are carried. These are arranged on trolleys running on four sets of lines on the main deck. They are of the Sauter-Harlé type and they will be launched through two large specially designed doors arranged aft. These mines are designed so as to remain at a depth of 13 ft. below the surface of the water, and it is thought that the vessel with her draught of 10 ft. 8 inches will be able to sail above them in safety. We should imagine that it would need a fairly brave commander to do this saving in the calmest of weather!

The trials of the *Pluton* produced the following results:

Full Speed Trial

Mean speed	20.87 knots
Best run on measured mile	21.5 knots
Fuel consumption—	
Per square foot of grate area actual at 20.87 knots	77.5 lb.
Total per hour as specified	5.431 tons
Total per hour actual	5.146 tons
Per I.H.P. actual, on trial	1.869 lb.
Per mile as specified	608.3 lb.
Per mile actual	553.2 lb.
Revolutions, mean	272.4
Indicated horse-power	6161

Eight Hours' Consumption Trial

Mean speed	16 knots
Fuel consumption—	
Per mile as specified	162 lb.
Per mile on trial	150 lb.
Per hour as specified	2592 lb.
Per hour actual	2392 lb.
Per I.H.P. per hour on trial	1.41 lb.
Revolutions per minute	192.5
Indicated horse-power	1700

The main particulars of the *Pluton* are the same as those of the *Cerbère.* There are, however, some slight differences in the machinery. The two triple-expansion engines of the *Pluton* have cylinders with diameters of 19 inches, 29 inches, and 46 inches, with a stroke of 23 inches. The boilers are of the Normand water-tube type, with a grate area of 148.55 square feet, and a heating surface of 6926.65 square feet. They work at a pressure of 256 lb. per square inch, as do the boilers of the *Cerbère.*

We may add that these vessels were designed by Monsieur Ferrand, Engineer-in-Chief of Naval Construction, and that the *Cerbère* was constructed at the Chantiers de Bretagne at Nantes, while the *Pluton,* which was launched on March 10th last, was built at the Chantiers Normand at Havre.

—*The Engineer.*

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THE RESISTANCE OF GUNS

Captain Hector Bravetta, of the Italian Royal Navy, who is well known to students of naval matters on account of the many articles which he has contributed to technical reviews in Italy and abroad, has translated and united in one volume three important memoirs on the resistance of guns, which engineers Leon Coupaye and Peter Malaval (of the French Naval Artillery) had published in the *Mèmorial de l'Artillerie Navale.* From the instructive preface in which Captain Bravetta introduces the authors to the public, and in which he summarizes their ideas and places in evidence the results arrived at, we note that the above-named memoirs are three in number, two being due to Mr. Coupaye, and one to Mr. Malaval.

The first of Engineer Coupaye's memoirs, which is entitled "Notes on the Calculation of the Transversal Structure of Guns," is the exposition and development of a method for calculating the resistance of artillery, ***based solely on the limitation of the tangential dilatations,*** the only factor which, up to the present time, has been taken into consideration, possibly on account of a mistaken notion, that it is the simplest mode of calculation.

The author has treated the problem in a generical manner, and has therefore been enabled to discuss the elastic limit to be adopted, for the elements of each section, and it is for this reason that in his second memoir, "Elastic Deformation of the Straight Cylinder, Guns with Purely Elastic Deformations," he limits himself to the calculation of a gun of which deformations are always elastic and never permanent; he presents the general lines of his subject only, and refers the student requiring a more complete treatment to the analogous questions which are dealt with in the first memoir.

In his second work, Mr. Coupaye has developed the study of the deformation of the straight cylinder; a study which, as far as we know, had not yet been dealt with, and which could and should by itself alone indicate the limits of application of the generic formulas used and their value. The result of this study is most important, for it has clearly brought into evidence that, calculating the strength of artillery, the end which the constructor of cannons has in view must in the generality of cases be taken into account; which end consists in the construction, at least practically, of a gun which, while firing, is affected only by elastic deformations.

The fact that the radial might become greater than the tangential deformation was already known and Kaiser has taken this point into consideration in his celebrated work; however, the exhaustive treatment of the matter by Engineer Coupaye has brought into evidence a most important circumstance, which has, up to the present moment, escaped the attention of constructors of artillery, *i.e., that it is absolutely impossible to build guns having purely elastic deformations* of a power superior to the limit of elasticity of the metal of which the internal tube is made and that the power effectively and practically realizable is about equal to nine-tenths of such elastic limit. This is true, whatever system of manufacture be adopted, both with regard to built-up and wire-wound guns, so that Captain Bravetta is correct in observing that the conclusions of Engineer Coupaye dispose of the legends as to the extraordinary powers of resistance attributed to guns constructed on this latter system, of which he requires the abolition in view of the considerable disadvantages which are inherent to such weapons.

The laws of elasticity have, therefore, proved in an irrefutable manner the following points: The elastic resistance of a gun is very limited, for, if the metal forming the internal tube possesses, for example, a limit of elasticity of 40 kilos, a piece of artillery of normal thickness will become deformed in a permanent manner under an internal pressure of 3600 kilos or more per square centimeter. Therefore, with weapons as at present constructed, it is impossible to fire at a higher pressure than that considered as normal. This does not necessarily mean that the present artillery must always burst transversally under the action of an internal pressure superior to the normal; in fact, it is known that with modern steel there is an appreciable difference between the limit of elasticity and that of rupture, which constitutes a precious margin of security for the system; however the permanent deformation which would follow, would be of such a nature as to modify the reciprocal relations of the various parts of the gun and would also influence the behavior of the projectile in the barrel. At all events the whole of the gun would not be invariable and would always be exposed to the danger of a pressure exceeding, even slightly, the relatively small pressure which produces permanent deformations; the limitations resulting are a most serious hindrance in view of the modern tendency to adopt ever-increasing pressures.

As will be seen from the preface, the calculation of artillery on the basis of radial deformation is not only useful, but absolutely necessary where it is required to use relatively high pressures, and Captain Bravetta has most opportunely summarized the investigations made on this subject by Engineer Bianchi, lieutenant-colonel in the Italian Artillery, who has sought the formulas necessary for such calculations, demonstrating that they are not more complicated than those now in use based on tangential dilatations; the observations and conclusions of Lieutenant Colonel Bianchi are of great interest and importance.

Engineer Malaval has also demonstrated that the present pieces possess an elastic resistance not greater than nine-tenths of the limit of elasticity of the metal forming the internal tube; the maximum importance of his researches, however, consists in the fact that he demonstrates the possibility of constructing guns capable of supporting the enormous pressure of 10,000 kilos per square centimeter, without any deformations resulting when the piece returns to a state of repose.

Mr. Malaval has brought these facts into evidence during the course of his special and profound investigations of the deformation of the tube beyond the elastic limit of the metal of which it is constructed; he has shown that a plain tube, when it becomes deformed, assumes of its own accord the ideal constitution of continuous forcing which would result from the union of an infinity of infinitesimal tubes put together in such a manner that they simultaneously reach their limit of elasticity, and, in consequence, all act equally under the application of an internal pressure. To put the matter briefly, Mr. Malaval would substitute partial forcing, by the continuous forcing realized by the autoforcing of the tube under the action of pressures which deform it in a permanent manner. On the other hand, this deformation results in a new state of elastic equilibrium which will remain invariable until the internal pressure (to which the tube will afterwards be submitted) exceeds the maximum of deformation. This new method, which leads to the consideration of the utilization of practical or accidental pressures, greatly superior to those now in use, will also permit, without doubt, an economy in the cost of workmanship, as the guns, remaining of the same thickness as before, may be built up of a lesser number of elements.

It will therefore be seen that the essays under consideration are of a most important nature, meriting attentive study on the part of land and marine artillery services. We would also call the attention of our readers to the preface, in which are expounded many ideas worthy of serious consideration. In the construction of guns it is important, even more than in the case of other machines, to follow the path of progress, it being a dangerous matter to tread stubbornly the beaten way, out of habit, over-conservatism, or worse.

Apropos of this matter it is most interesting to note that the Italian R. Navy, which has for some years past adopted exclusively the wire-wound system of construction, has now abandoned this, and is at the present time constructing some of her new colossal 381 millimeter guns on the built-up system. This fact gives a character of great actuality and interest to the work of engineers Coupaye and Malaval, Lieutenant Colonel Bianchi and Captain Bravetta, as it indicates to a certain extent the technical trend which is being followed in Italy, a pioneer country in the matter of progress and much esteemed for the high intellectual capacities of her officers, who make a point of keeping themselves in touch with all matters appertaining to scientific progress, with a view to their practical utilization.

Turin, 1913. Editor Carlo Pasta, Piazza Castello, 22.—*Journal of the United Service Institution.*

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THE *IRON DUKE* CLASS OF BATTLESHIP AND END-ON FIRE

The student of naval design cannot have failed to notice in the great increase to the end-on fire in the later type of warships a steady movement towards a reversion to former ideas in regard to war tactics. A few years ago the call was primarily for broadside fire, but now the tendency is to concentrate as far as possible the guns in the fore-quarter of the ship, with a main line of fire parallel with the fore and aft line of the ship, in association with as great an arc of training on the broadside as the former condition permits. The practice of fitting primary guns in two forward barbettes at different levels, so that the guns of No. 2 turret may fire over those in No. 1, conduced to this end, and has been adopted in all ships built since the *Orion* was laid down in 1909. A corresponding arrangement is adopted aft with four guns, while two more guns are placed amidship. Including the *Orion*, there are built, or in progress, twenty-two battleships with this system. Progress, however, has been marked in the size of the lighter guns and in their emplacement to increase end-on fire. The vessels up to and including the *King George V*, numbering seventeen, were fitted with 4-in. guns, but the ships since that period carry 6-inch guns, in association with 13.5-inch or 15-inch weapons in the barbettes. The 4-inch guns in the earlier ships were unprotected, except by shields, but in later ships the principle was adopted of grouping them in forward and aft batteries, forming part of the superstructure of the ship. The plating of these in the newer ships is of increased thickness and shot-resisting strength. In vessels now in commission, only four of these lighter guns can be fired ahead in line with the keel, but in the case of the *Iron Duke*, which marks a great step in connection with this provision of end-on fire, eight of the 6-inch guns can be fired ahead as well as on the broadside, and all of these are within armor. The fact is revealed in the [frontispiece]. It will be seen from this view that the casemates with the 6-inch guns are stepped from the center of the ship outwards, the gun nearest the center line being furthest forward, and the others towards the side of the ship stepped back. Thus while they all fire ahead, they can be trained to fire a few degrees abaft the beam. There are thus four 6-inch guns on each side of the main barbette for the 13.5 guns. In the same battery, firing aft as well as on the beam, there are two guns. The remaining weapons of this caliber are aft. The ships of the *Iron Duke* class, therefore, with four 13.5-inch guns and eight 6-inch guns forward have a greater end-on fire than any previous ship. This result has been rendered possible, in part, by the great beam of the ship, which is 90 ft., as by this means it was possible to get the lighter guns, with their mountings, abreast of each other, although not directly in the same athwartship line, along with the large barbettes required for the two twin mountings of the 13.5-inch guns. The ships of the *Iron Duke* class, it may be added, are 580 ft. in length, and have a displacement of about 25,000 tons. They are exceptionally well armored, and have Parsons compound turbines driving four shafts and propellers, to attain a speed, under easy steaming conditions, of 21 knots.—*Engineering.*

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SECOND NOTE ON THE CORRECTION FOR WIND

By P. Charbonnier, Chief Engineer of Naval Artillery (France)

1. In a previous note* we have considered the problem of the effect of a wind of velocity w_2 blowing perpendicularly to the plane of departure, under the supposition that the oblong projectile was always resting upon the horizontal projection of the trajectory with its axis tangent thereto.

That is a limiting case, which indicates that the usual correction is too small; it corresponds to the case of the rocket or the arrow. But, with an oblong projectile rotating rapidly about its axis, the assumed tangency will not, in general, occur; so it is necessary to consider now a second limiting case, which it would seem, moreover, is more nearly approximated in practice.

Let us assume that the axis of the projectile, in horizontal projection, remains parallel to itself throughout its flight—though it may describe about its mean position a precessional cone, without that oscillation's (because of its variable direction) having appreciable influence upon the motion of the center of gravity, which is what we are concerned with here.

2. The method of calculation to be used is entirely analogous to that we have employed before.

The action of the wind w_2 gives rise in the first place, as has been said, to a *corrective acceleration* for which the expression is:

$$E_t = \frac{kw_2}{u}\, cF\,(u).$$

But, because the axis of the projectile remains parallel to itself, the inclination η of the trajectory of the center of gravity to the axis will result in a complementary oblique resistance of which the component perpendicular to the axis of the projectile is $k\eta\, cF\,(u)$. Since this acts in a direction contrary to the first, the total corrective acceleration has as its expression:

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* See the JOURNAL OF THE U. S. ARTILLERY, Vol. 41, No. 1, January-February, 1914, Whole No. 125, p. 112.

$$E_z = k\left(\frac{w_2}{u} - \eta\right) cF\,(u)$$

The equation that gives the angle η will then be

$$\frac{d\eta}{du} - \frac{(k-1)\eta}{u} + \frac{kw_2}{u^2} = 0$$

It is a linear equation which is easily integrated.

The equation without second member

$$\frac{d\eta}{du} - (k-1)\frac{\eta}{u} = 0$$

admits as intergral $\eta = Au^{(k-1)}$, A being a constant which is determined by the formula:

$$\frac{dA}{du} = -kw_2\frac{1}{u^{k+1}}$$

whence,

$$A = w_2\left(\frac{1}{u^k} - \frac{1}{u_0^k}\right)$$

and we have:

$$\eta = \frac{w_2}{u}\left[1 - \left(\frac{u}{u_0}\right)^k\right]$$

also:

$$dz = \eta\,dx = -\eta\frac{udu}{cF}$$

and we have:

$$z = \frac{w_2}{c}\left[\frac{1}{u_0^k}\int_{u_0}^{u}\frac{u^k du}{F} - \int_{u_0}^{u}\frac{du}{F}\right]$$

This formula would require the numerical calculation of a new ballistic function:

$$\int_{u_0}^{u}\frac{u^k du}{F}$$

It is seen that this formula appears in a form very different from that which results from the other hypothesis. However, the two formulas coincide for values of u close to u_0.

4. In order to obtain an approximate formula, sufficiently accurate for all practical purposes, let us substitute for the factor u^{k-1}, under the sign of integration, a mean value u^{k-1}, in which μ can be taken as equal to

$$\frac{u_0 + u}{2}$$

We shall have:

$$z = w_2\left[\frac{1}{cu_0}\left(\frac{\mu}{u_0}\right)^{k-1}\int_{u_0}^{u}\frac{udu}{F} - \frac{1}{c}\int_{u_0}^{u}\frac{du}{F}\right]$$

or,

$$z = w\left[t - \left(\frac{\mu}{u_0}\right)^{k-1}\frac{x}{u_0}\right]$$

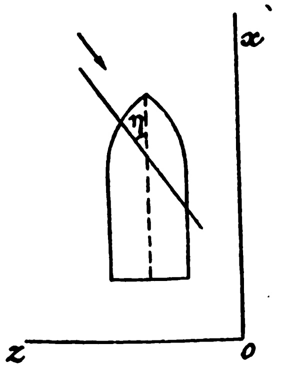

FIG. 1. 1476

5. *Case of a monomial resistance.*—Placing

$$cF(u) = b_n u^n$$

we have:

$$z = \frac{w_2}{b_n u_0^{n-1}}\left\{\frac{1}{n-1}\left[\left(\frac{u_0}{u}\right)^{n-1} - 1\right] + \frac{1}{k-n+1}\left[\left(\frac{u_0}{u}\right)^{k-n+1} - 1\right]\right\}$$

For $n = 2$, it becomes:

$$z = \frac{w_2}{b_2 w_0}\left[\frac{u_0}{u} + \frac{1}{k-1}\left(\frac{u}{u_0}\right)^{k-1} - \frac{k}{k-1}\right]$$

—*Revue d'Artillerie.*

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WIND DEFLECTION

The usual calculation for estimating how much a projectile is deflected by wind assumes that the lateral surface or form of the projectile has no effect on the behavior to be noted. No less an authority than Charbonnier states, in a recent article on this subject, that "the usual formulæ make no distinction between a long projectile and a short one, but reason demands that the action of wind on the two must differ." He then shows by mathematical analysis that the lateral form, that is the profile as viewed from the side, is a factor, irrespective of the ballistic coefficient, and he draws the following conclusions: To take account of the influence of form, a factor for the *coefficient of oblique resistance*, *k*, must be introduced. A cross wind causes a lateral deviation equal to that given by the usual formulæ multiplied by *k*. This factor depends on the form of the projectile's nose, and for the more usual types has a value between two and three. For the more pointed types the value may be as large as seven or ten. The long pointed projectiles will therefore be very sensitive to a cross wind.

These conclusions of Charbonnier are remarkable, and at the same time are most emphatically at variance with the experience of riflemen. The difference in wind deflection between two bullets is not easy to estimate, but the oft-repeated observations of scientific riflemen, firing side by side, may be taken as of great weight. Observations at the range, made in the most careful way, have demonstrated that the usual formulæ, which ignore the lateral form of a bullet, give the relative wind deflection of pointed and blunt nose bullets with great accuracy. If Charbonnier was right the pointed bullets would have no advantage over the blunt form of nose as far as wind is concerned. In fact in some instances they would work at a positive disadvantage. Experience could not be more definite than it is in proving that Charbonnier is wrong.—*Arms and Explosives.*

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EXTRACTS FROM THE BIMONTHLY ORDNANCE REPORT

FOR JANUARY-FEBRUARY, 1914

THE ORDNANCE BOARD

Illuminating rifle grenades.—Tests satisfactory. Certain modifications in details recommended.

Investigation to determine if broad banded projectiles produce greater erosion than those with narrow band.—Measurements indicate slightly greater erosion by the broad band at the initial position of projectile; at other points along bore erosion is greater with narrow banded projectiles. Results on whole are favorable to the broad band.

Tests of material in progress.—

Subcaliber gun for 3-inch field gun.
Subcaliber gun for 4.7-inch howitzer.
Metal containers for storing gas check pads.
Gardom patent gas check pad.
Gas check pads, covering used by U. S. Navy.
Heavy canvas covering for gas check pad.
Gas check pads made with Special K No. 4 non-fluid oil.
Experimental dummy projectiles.
Mr. J. H. Brown's method of banding projectiles to prevent erosion.
Development of an improved cable connection between firing mechanisms of seacoast cannon and breech block.
Picatinny Arsenal experimental shavings maneuver powder.
Single wire simple electric primers, improved design.
New model two wire electric primer.
Soft nose bullet for subcaliber cartridge, 2.95-inch mountain gun.
High explosive bursting charges in papier-maché cartons.

FRANKFORD ARSENAL

6-inch common shrapnel.—The design of a 6-inch common shrapnel similar to the design of the 4.7-inch common shrapnel has been undertaken.

5-inch siege gun shrapnel.—A ballistic sample of 5-inch siege gun shrapnel fitted with Frankford Arsenal 45-second combination fuses has been shipped to the Sandy Hook Proving Ground for test.

3.8-inch and 4.7-inch shell.—Both sizes of shell have been tested satisfactorily at the Sandy Hook Proving Ground.

2-wire simple electric primer.—One hundred of those primers have been forwarded for test at the Sandy Hook Proving Ground.

Single wire electric primer.—An experimental lot of 200 primers now at the Sandy Hook Proving Ground.

Bridge anvil type primer.—A new type of primer to replace the disc anvil type of primer in high explosive shrapnel and in detonating fuses has been developed. This primer has been called bridge anvil type. The disc anvil type primer was not thoroughly satisfactory in jumble and jolting test. The new primer withstood these tests very satisfactorily.

Testing resistance of primers.—An instrument has been installed in the Primer Shop at this arsenal for measuring the resistance of simple electric and combination electric friction primers. This instrument employs the principle of the Wheatstone Bridge. It is proposed to make the resistance of all primers come within established limits in future manufacture.

Pratt range board, model of 1905.—The design has been approved and an order received for the manufacture of sufficient rulers of the new design to modify all Pratt range boards for the regular service and the militia.

Panoramic sights, model of 1913.—An order has been received to prepare the necessary drawings and manufacture four panoramic sights, model of 1913. These sights are to have an additional scale for use in making smaller individual changes in deflection of the different guns in the battery.

120-degree plotting boards.—The 120-degree plotting board, according to the design submitted by the Chief of Coast Artillery, has been completed and is awaiting inspection and test.

3-inch telescopic sights, model of 1904.—Work has been undertaken to provide rubber hoods for all 3-inch telescopic sights, model of 1904, below serial number 297.

ROCK ISLAND ARSENAL

Observation tower.—An experimental observation tower for use of the field artillery is being manufactured at this arsenal. This tower is designed so that it can be easily attached or removed from the 3-inch gun caisson, model of 1902.

WATERTOWN ARSENAL

Mortar shot trucks.—Manufacture of 18 shot trucks, type 12:DC, for 12-inch mortar carriage, model of 1891.

For March–April, 1914

THE ORDNANCE BOARD

A. C. magneto firing device for seacoast guns, with transformer.—Tests completed and report submitted. Device is more promising than any means of electrical firing yet before the Board. Further improvements in electrical characteristics and in the mechanical features considered desirable. Test of the arrangement with wiring, contacts, cable connections, etc., complete in every detail, recommended.

Simple electric primers.—New design found entirely satisfactory. There were no failures in 200 primers fired.

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ESTABLISHMENT OF AN ARTILLERY SPECIALISTS SCHOOL IN RUSSIA

By prikase of October 24 (November 6), 1913, the specialists school and the school of pyrotechny are consolidated in one under the designation of the Scientific School of Ordnance.

This school is connected, in general organization, with the institutions of secondary instruction and is intended to prepare ordnance specialists, pyrotechnic specialists, and electricians. The students are organized in a company.

There are four classes, the first two being general for all students, and the last two being special and divided into three sections—ordnance, pyrotechny, and electricity. The course covers four years.

The school is under the supervision of the general artillery headquarters and is inspected for all purposes by the commandant of the Michel Artillery Academy, or by the commandant of one of the artillery schools, or by a general designated by the chief of bureau at the general artillery headquarters to whom falls the duty of superintending instruction.

The staff is made up of:

1 brigadier or major general, commandant of the school;
1 lieutenant-colonel or captain of artillery, company commander;
4 subalterns of artillery;
1 colonel or brigadier general of artillery, in charge of instruction;
1 field officer or company officer of artillery, in charge of laboratories;
6 rated artillery specialists, of whom 5 are teachers of trades;
2 rated pyrotechnic specialists, of whom one is foreman of the laboratory;
3 professors, military or civil;
1 surgeon and 2 hospital attendants;
5 clerks for the department of records, or administration;
1 steward.

The commandant of the school is, preferably, selected from the officers who have taken the courses at the Michel Artillery Academy, the selection being made by the chief of artillery and ratified by imperial prikase. He has the allowances of a regimental commander. His immediate subordinate is the officer in charge of instruction, who is selected in the same way.

The company commander, independently of the duties that are his naturally, is in charge of: (1) physical and moral training and work done outside of class; and (2) the business management.

The officer in charge of laboratories, who, under the commandant, is in charge of practical instruction in the different trades, is chosen by the commandant from among the officers of artillery who have taken the courses in the Michel Academy. This choice is confirmed at artillery headquarters. The various courses are taught either by officers who have taken the courses at the Academy or by artillery specialists.

There is a school board, a board for discipline, and an administrative council.

ENTRANCE CONDITIONS

Young men of all stations in life enter the school as the result of a competitive examination held in accord with regulations prescribed by the war minister. They must be at least sixteen and not more than nineteen years old.

Those desiring to enter make application to the commandant before the tenth of August of the year in which the competitive examination takes place. The examination is held in the second fortnight of August. As a preliminary, they pass a physical examination held under the same rules as those that govern admission to the military schools.

The students are admitted at the expense of the Government. There are 100 of them. More may be admitted, but at their own expense. The first are regarded as being regularly in the military service and take the oath. While the time spent at the school affects the student's seniority in the service, yet it does not count as compulsory military service.

PROGRAM OF INSTRUCTION

Instruction in the school includes:

1. *General instruction.*—Russian language; algebra; geometry; trigonometry; analytical geometry; mechanics; natural philosophy; chemistry; geography; cosmography; history; law; hygiene; drawing; German.

2. *Special instruction.*—(a) Ordnance section: artillery; applied mechanics; technology; electricity; military administration and correspondence; fortification; mechanical drawing; descriptive geometry.

(b) Electrical section: artillery; electricity as applied in artillery; general electricity; applied mechanics; technology; military administration and correspondence; fortification; mechanical drawing.

(c) Pyrotechnic section: artillery; powders and explosives; manufacture of cartridges, cartridge cases, primers, and fuses; chemistry; applied mechanics; electricity; military administration and correspondence; fortification; mechanical drawing.

3. *Practical instruction.*—(a) Ordnance section: trades of locksmith, joiner, tinner, and blacksmith; detailed knowledge of rapid fire artillery material; practical experience in ordnance shops; practical experience in telephony; experiments in physics.

(b) Electrical section: practical experience in general electricity and in the use of electricity in the artillery service; practical work with motors used in fortifications; practical mechanics, physics, and chemistry; trades as in (a).

(c) Pyrotechnic section: practical experience in ordnance shops and in the military explosives laboratory; applied mechanics, chemistry, and physics; trades as in (a) and (b).

The theoretical work is from November 1st to May 15th, including the annual examinations. From May 15th to July 1st is devoted to practical work.

Promotion from one class to the next is made by the school board, subject to the approval of the commandant.

The proportion of time given to the theory and the application of each subject, the total number of hours alloted each, the standard for promotion from one class to the next, and the standard for the final examination, are fixed by the school board, then submitted to the artillery board at headquarters, and finally approved by the secretary, or minister.

GRADUATION

The members of the fourth, or highest, class are divided into three grades, according to their standing. Then, according to the special courses they have pursued, they are designated ordnance specialists, pyrotechnic specialists, or electricians; and, according to their grades, they are assigned to fill vacancies in the various artillery, or ordnance, plants.

The graduates are appointed:

1st grade.—To the XIVth rank, or category, with two years seniority.

2nd grade.—To XIVth rank, or category, with one year seniority.

3d grade.—As "candidates," with the right to promotion within a year, provided they are considered competent by their local commanding officers.

Upon graduation, the students are given an equipment fund of 250 rubles (665 francs).

Every student who takes the entire course, whether at his own or the Government's expense, is obliged to remain four years in active service, at the call of the artillery branch.—*Revue Militaire.*

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OFFICERS' SCHOOL AT PAOTINGFOU, CHINA

Prior to the revolution, military instruction for officers was given in schools of two grades: preparatory schools; and intermediate schools.

The Paotingfou school is intended to take the place of the two former schools. To it are admitted students who have served a term of six months as non-commissioned officers in a regiment; and upon their departure from the school the students, before being promoted officers, go back to their original units to serve a second term.

The course is two years. There is only one class every two years.

The 1200 students are of an average age of twenty years, and come from all China.

The school staff comprises: headquarters; military professors (32), who were nearly all educated abroad, especially in Japan; civilian professors of languages (13); and company officers (48).

The students are organized in twelve companies of 100 each, under the command of a captain and three chiefs of platoon, as follows: six companies of infantry; two of cavalry; two of artillery; one of engineers; and one wagon company.

The practical training (drill, target practice, and field service) is given by the company officers. For theoretical instruction, given by the military and civilian professors, the students are organized in twenty-four sections of fifty each.

One fourth of the time is alloted to study, and three fourths to practical instruction. One afternoon each week is given up to field service, and another to target practice.

The uniform is that of the men of the army (gray cloth or cotton, according to season) with a star on the cap and the company number on the collar ornament. The knapsack and accouterment are the same as those of the army, khaki. The arms include: Mauser rifles manufactured in Shanghai; Mauser carbines, model 1888, of German origin; four Krupp field guns; and four Krupp mountain guns.

Expenses are allowed and the students are granted a little pocket money for modest spending.—*Revue Militaire.*

HORSE-POWER OF SMALL GAS ENGINES

The method of computing the indicated horse-power of a gas engine running at slow or moderate speed follows so closely the procedure for steam-engine practice that seldom any misunderstanding arises. The principal point to bear in mind is that in the $\frac{PLAN}{33{,}000}$ formula N must represent the number of explosions which in a hit-or-miss governed engine may not bear any definite relation to the revolutions per minute. Moreover, in a gas engine a stiffer spring must be used, owing to the high explosion pressures.

With small high-speed engines running at 800 to 1000 revolutions per minute the problem is quite different. Here the speed is too high to obtain accurate results with an ordinary indicator; hence, it is usual to estimate the mean effective pressure. The latter, however, will vary with the load and is dependent upon several factors, including the mixture, the compression pressure, and the time of ignition. Therefore, when running underloaded it is practically impossible to arrive at the horse-power, without actually measuring the brake horse-power. The full-load horse-power may be estimated, with fairly close approximation, however, if the cylinder dimensions and speed are known, by assuming a mean effective pressure for full-load conditions. With tight valves and pistons a mean effective pressure of 80 pounds may be taken for gasoline, 75 pounds for natural or illuminating gas and 65 pounds for producer-gas; then substitute this value for P in the formula.

$$\textit{Horsepower (per cylinder)}^{*} = \frac{PLAN}{33{,}000 \times 12}$$

Where

P = Mean effective pressure;
L = Length of stroke in inches;
A = Area of piston in square inches;
N = Explosions per minute.

This may be written:

$$\textit{Horse-power per cylinder} = \frac{P\,L\,0.7854\,D^2\,N}{33{,}000 \times 12}$$

where D = *diameter of cylinder.*

Substituting for gasoline:

$$\textit{Indicated horse-power} = \frac{80\,L\,0.7854\,D^2N}{33{,}000 \times 12} = \frac{D^2\,L\,N}{6300}$$

Assuming a mechanical efficiency of 85 per cent.

$$\textit{Brake horse-power} = \frac{D^2\,L\,N}{6300} \times 0.85 = \frac{D^2\,L\,N}{7400}$$

This formula may be expressed in other terms to suit special conditions. For instance, in a four-stroke-cycle engine with jump-spark ignition where an explosion occurs at every second revolution, N may be taken as the revolutions per minute and the formula will become

$$\textit{Brake horse-power (per cylinder)} = \frac{D^2\,L\,N}{14{,}800}$$

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* Strictly speaking, this should be "per cylinder per end," but as the present discussion deals only with small engines, which are always built single-acting, the formula may be understood to give the horse-power per cylinder.

This is the more familiar form, but it has been further simplified by the American Licensed Automobile Manufacturers Association in assuming a piston speed of 1,000 feet per minute, which is equivalent to a 6-inch stroke and 1000 revolutions per minute, or, 5-inch stroke and 1200 revolutions per minute. Using the round number 15,000 for the denominator this reduces to:

$$\textit{Brake horse-power (per cylinder)} = \frac{D^2 \times 6 \times 1000}{15,000} = \frac{D^2}{2\frac{1}{2}}$$

This is the formula by which automobile engines are rated.

—From *Power* in *Scientific American Supplement.*

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OPERATING A TORPEDO FROM A LAND STATION

United States army and navy officers are deeply interested in a mechanism invented by John Hayes Hammond, Jr., for operating a torpedo by non-interferable radio impulses from a land station. To bring about the realization of the system necessitated, it is said, the taking out of fifty patents and the expenditure of thousands of dollars and an immense amount of labor at the Hammond Radio Research Laboratory in Gloucester, Mass.

Considerable secrecy surrounds Mr. Hammond's mechanism, and he said in response to a request from *The Wireless Age* for information regarding his invention that "inasmuch as the U. S. army officials are cooperating with me to-day in my work you will, of course, understand that all the matters of my laboratory are confidential." He has, however, it was learned, brought his invention to such a degree of perfection, after many months of experimenting, that officers of the navy and army have agreed to witness his tests.

Hitherto it has been possible to operate a torpedo from shore at an eight-mile speed, but the control has always lacked the fundamental essential of immunity from interference by an enemy. That is, a hostile battleship against which a land-operated torpedo might be directed, could, with its own wireless radio impulses, interfere and negative those of the land station.

Mr. Hammond's invention is credited with making such interference a boomerang for an enemy, for with his new device, in case interference is attempted, the radio forces impelling the projectile, instead of losing their efficiency, are strengthened, and the torpedo is drawn toward its mark at an increased rate of speed.

In the little bay near Gloucester harbor's mouth, beneath the bluffs, where tower the twin finger-like wireless masts, 360 feet high, which Mr. Hammond has built, lies a fifty-foot "house boat" recently remodeled for wireless control operations which the inventor, standing at a mysterious keyboard in his laboratory, can at will put through its paces out in the bay—two, three, four miles from there, running at a twelve-miles speed, turning, stopping, backing, starting forward again, without interference by any one on board if there happens to be any one.

The predecessor of this "house boat," the *Radio*, a speedier type, was operated by wireless waves at a thirty-three-knot rate. When the navy experts heard of this and satisfied themselves as to its truth, they requested Mr. Hammond to continue the experiments with a slower type, with the result that the Hammond "house boat" was refitted for the radio tests.

—*Proceedings U. S. Naval Institute.*

Short Notes

British Coast Defenses.—The Royal Artillery Institution recently held a prize competition for the best essay on British coast defenses. The five essays considered best by the judges have now been published, and are remarkable for the unanimity with which the essayists condemn England's present coast armaments. They all point out, the Army and Navy Gazette tells us, that the 9.2-inch gun, the heaviest weapon mounted on British coasts, is of little use against modern battleships, and should be replaced by a gun of 12-inch, or even larger caliber. Special guns for engaging the enemy's dirigible balloons, and air craft of our own for reporting the approach of his ships, are also considered indispensable.—*Army and Navy Journal.*

Aerial Coast Defense in Great Britain.—It is gratifying to find that, after all, we are not so far behind as many of the expert Admiralty critics would have us believe in the naval wing of our aerial department, at least, so far as coast protection is concerned. We have established six stations for seaplanes along that part of our coasts to which all eyes are directed when war clouds lower, and considerable accommodation for the battleships of our aerial fleet is being provided in the Medway Valley. There is likewise a seaplane station as far south as Calshot, at the entrance of Southhampton Waters, and others are in course of construction on parts of the coast more remote from what, for several years, we have now been looking upon as the danger spot—the North-East Coast. That is not a bad year's work for 1913, and probably places us well ahead of any of our rivals in introducing aerial war machines into the realm of coast protection. During the present year, however, we may reasonably expect to see this record easily eclipsed, as there has been ample time to fully consider our immediate needs, and to conclude contracts for the construction of more aerial stations. With Yarmouth, Calshot, Firth of Forth, Cromarty, Felixstowe, and Isle of Grain equipped and in full "commission," and a large number of air pilots trained and under training, the Naval Wing of the Royal Flying Corps has, at last, made a satisfactory start.—*United Service Gazette.*

The Oklahoma.—The *Oklahoma* is a sister ship to the *Nevada*, under construction by the Fore River Shipbuilding Company of Quincy. Each of these ships is 583 feet over all, 575 feet on designer's load water line, 95 feet 2½ inches beam, 28 feet 6 inches draught on a displacement of 27,500 tons, with two-thirds full supply of stores and fuel, and full supply of ammunition. The contract speed is 20½ knots. The *Nevada* will be propelled by Curtis turbines, and the *Oklahoma* by reciprocating engines; the machinery driving twin-screws in each case. The main armament will consist of ten 14-inch 45-caliber guns, all in line of keel, and mounted in four turrets, two of which have three guns each.

The anti-torpedo battery will consist of twenty-one 5-inch 51-caliber guns and four 3-pounder guns will be carried for saluting purposes. Four 21-inch submerged torpedo tubes will also be fitted. Both the *Oklahoma* and *Nevada* will have two cage masts and one funnel. They are the largest capital ships in our navy, and will carry 598,400 gallons of oil, weighing 2000 tons, designed to burn oil fuel exclusively. The armor belt is 13½ inches thick and the casing of the barbettes 13 inches thick. On the turrets, the thickness of armor varies from 9 to 18 inches in thickness, with 16 inches on conning tower and range-finding station. The gun deck will be protected with 3-inch steel and the protective deck with 2-inch steel. The secondary or anti-torpedo battery will be left unprotected; an arrangement which foreign navies are now following. The armor plates will be laid vertically along the water line belt, instead of horizontally in two strips as heretofore. The keel of the *Oklahoma* was laid on October 26, 1912. Her complement will be fifty-five officers and 808 men.—*Army and Navy Journal.*

Laying Keel of No. 39.—The laying of the keel of *No. 39* constitutes the commencement of the building of a 31,400 ton battleship for the United States Navy. *No. 39* will be equipped with Parsons turbines, and the vessel's general dimensions are as follows: Length under the water line 600 feet, length over all 608 feet; breadth, extreme at the water line 97½ feet; the main trial displacement 31,400 tons; mean draft 28 feet 10 inches with a fuel storage capacity of 2322 tons; minimum speed of not less than 21 knots. Her main battery will consist of twelve 14-inch 45-caliber breech loading rifles, and four submerged torpedo tubes, with a secondary battery of twenty-two 5-inch 51-caliber rapid firing guns, four saluting guns, three pounders, 2 one-pounder and two 3-inch field pieces and two .30 caliber machine guns. Her plans call for two triple-gun turrets forward and two aft on a center line. *No. 39* will have two cage masts and a single funnel.
—*The Navy.*

U. S. S. Texas and H. M. S. Iron Duke Compared.—The British battleship *Iron Duke* and the U. S. *Texas* were commissioned on the 10th and 12th March respectively. The following is a comparison of the two ships:—

	Iron Duke	*Texas*
Laid down	15th Jan., 1912	17th April, 1911
Time to build	26 months	35 months
Length	580 feet	565 feet
Beam	90 feet	95 feet 2½ inches
Displacement	25,000 tons	27,000 tons
Horse-power	29,000	28,100
Speed, designed	21 knots	21 knots
Main belt	12 inches	12 inches
Principal guns	10 13.5 in., 12 6-in.	10 14-in., 21 5-in.
Fuel: Coal	2700 tons	2850 tons
Oil	1000 tons	400 tons

The weight of the heavy-gun projectile is the same in both cases—1400 lbs.—*United Service Magazine.*

The German Dreadnought Kronprinz.—The *Kronprinz* was laid down in 1912, and will take her place in the high sea fleet in the summer of next year. She will have a displacement of 27,000 metric tons and will carry ten 12-inch 50-caliber guns, all on the center line in five turrets, the penultimate pairs firing over the forward and aft pairs; fourteen 6-inch guns of 50 calibers, and twelve 3.5-inch guns of 45 calibers, as well as two machine guns. Her torpedo armament will consist of five 20-inch tubes, four on the broadside [illegible] at t[illegible] Her protection [illegible] be 14-inches thick for the turret[illegible] for the conni[illegible]. She will be propelled at [illegible] horsepo[illegible] will cost in round numbers 50 million marks—say, 2½ million pounds sterling—of which 30 million marks will be spent on the hull, 18,700,000 on the guns, and 1,370,000 on the torpedo armament.

The *Kronprinz*, which was known up to the time of her launch as the *Ersatz Brandenburg*—that is to say "the ship replacing the *Brandenburg*"—is the second of the name in the German navy. The first was built by Samuda in 1866-7. She displaced about 5770 tons, and was a full-rigged armored frigate carrying sixteen short 8-inch breech-loading guns and six pivot guns. The present ship belongs to the *König* class, but is larger than her sisters.

We may add that the leading particulars of the *Brandenburg*, which was built at the Vulcan works, Stettin, and was launched on the 21st January, 1891, were as follows: Displacement, 10,000 tons; two engines, each of 9000 indicated horse-power; speed, 16 knots; guns: four 28 cm. 40-calibers, two 28 cm. 35-calibers, eight 10.5 cm. 35-calibers, and eight 8.8 cm. 35-calibers; submerged torpedo tubes: one 45 cm. in the bow and two 45 cm. on the broadside.—*The Engineer.*

Japanese Battleship Fuso.—The Japanese battleship *Fuso* was floated out of the dry dock at Kure on the 28th March, and is stated to have had her engines and guns in place at the time. The displacement of this vessel is about 30,000 tons, the armament consisting of twelve 14-inch and sixteen 6-inch guns. Battleship No. 4, a sister to the *Fuso*, is declared by the *Marine Rundschau* to have been laid down in February; but as a result of the large reductions in the budget, there is some prospect of it being impossible to proceed with the work of construction for some time to come. Batleships No. 5 and 6, which are to be built at Kobe and Nagasaki respectively, have not been laid down.—*United Service Magazine.*

France to Build 16-Gun Dreadnoughts.—On January 1st, 1915, the French Admiralty will commence the construction of four super-dreadnoughts of about 29,000 tons, which will each carry sixteen 13.4-inch guns in four quadruple turrets. These ships will be able to fire eight guns ahead, eight astern and sixteen on each broadside. The French believe that these ships will be superior to the British *Queen Elizabeth* type, which can concentrate half the number of 15-inch guns in the several directions of fire, or four ahead and astern and eight on each broadside.—*Scientific American.*

Improved Submarines.—Submarines, like aeroplanes, are still associated in the public mind with records of disaster, but the lessons which have been learned from past accidents have enabled the designers to produce a type of vessel for which it is claimed that risk has been reduced to a minimum, and that a man serving in one of these latest submarines is as safe as if he were serving on a Dreadnought. If this claim can be substantiated it will be good news. Experts may be pardoned for their sublime confidence in the products of their own skill and ingenuity, but the accidents which have happened in the recent past are too fresh in the memory of the public to permit of their taking a too optimistic view, until the claim has been further tested by time and experience. The authorities, however, appear to be so impressed by the degree of safety which really appears to have been at last attained, that it is reported they no longer regard service on submarines as being so exceptionally dangerous as to warrant the continuance of the system of manning them exclusively by volunteers paid at special rates. The proposal to appoint officers and men in the ordinary way to these vessels, just as they are now appointed to battleships, cruisers and torpedoboats, will not be popular, but it is hardly credible that the authorities would make such a drastic change, unless they were absolutely convinced that all exceptional danger has now been eliminated by the improved stability and sea-keeping qualities of the latest vessels, and the ingenious precautions against disaster with which they are now provided. If the nation could be equally convinced, we do not believe it would object to the cost involved in getting entirely rid of those submarines of the primitive types still in commission and used for instructional purposes. The terrible potentialities of these craft in action against huge battleships having been demonstrated and placed beyond doubt, no expense should be spared to secure an efficient and thoroughly modern flotilla.—*United Service Gazette.*

The British 15-Inch Gun.—One of the most important decisions for many years was the advance from the 13.5-inch to the 15-inch gun. In the *Queen Elizabeth* type, the Admiralty wished to have exceptional speed without any loss of gun-power or protection or undue increase in displacement. One of the five turrets had to be given up to find room for the extra boiler power, and in order to maintain gun-power it was necessary to increase the caliber of the guns. The whole of the 15-inch guns for the 1912-13 programme were ordered without ever a trial gun being made. When the first 15-inch gun was tried a year ago, it yielded ballistic results which vindicated the minutest calculations of the designer. It is the best and most accurate gun at all ranges we have ever had; it reproduces all the virtues of the 13.5-inch gun on a larger scale. It discharges a projectile of nearly a ton in weight, and can hurl this immense mass of metal 10 or 12 miles. The high explosive charge which the 15-inch gun can carry through and get inside the thickest armor afloat is very nearly half as large again as the charge in the 13.5-inch gun. Owing to the trust which we were able to place in our artillery science, we shall have ten ships armed with this 15-inch weapon by the time any other naval power has two.

—*Journal of the Royal United Service Institution.*

Notices

BUREAU OF MINES' PUBLICATIONS FOR FREE DISTRIBUTION

We have been asked to print the following:

DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

New Publications

(List 21.—August, 1913.)

Bulletins

Bulletin 59. Investigations of detonators and electric detonators, by Clarence Hall and S. P. Howell. 1913. 73 pp., 7 pls., 5 figs.

Technical Papers

Technical Paper 15. An electrolytic method of preventing the corrosion of iron and steel, by J. K. Clement and L. V. Walker. 1913. 19 pp., 10 figs.

(List 25.—January, 1914.)

Bulletins

Bulletin 66. Tests of permissible explosives, by Clarence Hall and S. P. Howell. 1913. 313 pp., 1 pl., 6 figs.

Miners' Circular

Miners' Circular 7. The use and misuse of explosives in coal mining, by J. J. Rutledge. 1913. 52 pp., 8 figs.

(List 27.—March, 1914.)

Technical Papers

Technical Paper 69. Production of explosives in the United States during the calendar year 1912, compiled by A. H. Fay. 1914. 8 pp.

Technical Paper 71. Permissible explosives tested prior to January 1, 1914, by Clarence Hall. 1914. 12 pp.

The Bureau of Mines has copies of these publications for free distribution, but can not give more than one copy of the same bulletin to one person. Requests for all papers can not be granted without satisfactory reason. In asking for publications, please order them by number and title. Applications should be addressed to the Director of the Bureau of Mines, Washington, D.C.

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BOOK REVIEWS

Report of the Chief Inspector of The Bureau for the Safe Transportation of Explosives and Other Dangerous Articles, February, 1914. 7½" x 10¼". 61 pp. 9 il. Paper.

A review of the Chief Inspector's report for 1913, giving an outline of the scope and arrangement, will be found in No. 121 of the JOURNAL. The report for 1914 is similar in all important respects to that for the preceding year. An analysis of this report yields much data of value to those interested in the transportation and handling of explosives and dangerous articles.

The efficiency of the Bureau is best shown by the results accomplished since its establishment, in 1907. During that year a total of 79 accidents occurred in the transportation of explosives, as a result of which 52 persons were killed and 80 injured, while the property loss was nearly half a million dollars. In 1912 only nine accidents occurred, all of a minor character, in which six persons were injured and $10,000 worth of property was destroyed; while in 1913 the number of accidents remained practically the same and the property loss was about $22,000, of which $18,000 was due to the deliberate exploding of a shipment of dynamite by a railroad employee in an attempt to defraud an insurance company, so that a loss of only $4000 can be attributed to accidents.

To gain a better understanding of the work done by the Bureau, these losses should be compared with the losses resulting from accidents in transporting explosives by carriers not subject to the Interstate Commerce Commission Regulations, e.g., steamship lines engaged in foreign commerce. In four accidents occurring during 1913, 57 persons were killed, 136 were injured and a property loss of nearly a million dollars was sustained by those affected. Furthermore, in the manufacture, storage, and use of explosives, 93 accidents were recorded, which resulted in the killing of 139 persons, the injuring of 178, and the loss of over $80,000 in property. It may be remarked that the property loss was unusually low, having been over one million dollars in 1911 and over two million dollars in 1912.

Of the 205 fires reported as occurring during the transportation of dangerous articles other than explosives, 77 were caused by "strike-anywhere" matches while only three were caused by safety matches. The property loss in the case of the former was nearly $27,000, while with safety matches no loss was sustained. Seventeen fires caused by gasoline, destroyed property to the value of $100,000. The total loss from the 205 fires was $276,000 and sixteen persons were injured.

Two hundred and sixteen accidents not resulting in fires were reported as occurring in the transportation of dangerous articles; but, though one person was killed and 20 injured, the property loss was small, about $5000. The fatality was due to the bursting of a receptacle containing the extremely corrosive hydrofluoric acid.

At a public hearing held by the Interstate Commerce Commission in

January, 1914, the Bureau of Explosives suggested certain changes in the transportation regulations which will probably be adopted by the Commission. Among these changes are the following:

1. The subject matter has been rearranged with a view to differentiating between the shipper's and the carrier's duties.
2. Smokeless powder for small arms has been transferred from the more dangerous to the less dangerous class. This will avoid the necessity of furnishing certified cars with the "Explosives" placard.
3. The number of blasting caps which may be shipped without certification and placarding of car has been raised from 500 to 1000.
4. Shippers will be required to mark all freight packages which are exempted from label on account of quantity or packing, "No Label Required." Articles included in the list which are not dangerous must also bear this marking.
5. Yellow labeled and white labeled articles may be loaded in the same car, provided they are loaded in separate ends of the car.
6. Wooden kegs, or barrels, cannot be used for the shipment of inflammable liquids with flash points below 20°F, such as gasoline, benzine, and naptha, after January 1, 1915.

Since 1908, quarterly bulletins have been sent out by the Bureau to members, describing and illustrating violations of the regulations of recent occurrence. In the report for 1914 are included the four bulletins issued during the preceding twelve months, from which the details of the various violations can be obtained.

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Chevaux et Voitures d'Artillerie. By P. Machart, Chef d'Escadron d'Artillerie. Paris: Librairie Militaire Berger-Levrault, 5-7, Rue des Beaux-Arts. 5½" x 9". 266 pp. 70 il. 2 plates. Paper. 1913. Price, 5 fr.

This is the second edition of a useful work which should be translated into English. We have many treatises on the saddle horse, but few or none on the draught horse. Formerly, scientific writers paid much attention to the study of the draught horse, but, since the advent of the railway, the subject has fallen into neglect. The artillery of all countries has been content to copy blindly the methods and accept the conclusions of the cavalryman, without regard to differences that must necessarily exist between a good mount and a good draught animal. Societies, men of wealth, and faddists have devoted much time, money, and thought to the development of the saddle horse; but they have forgotten the draught horse. It is true that breeders have devoted much attention to the heavy draught horse; but they have evolved veritable mastodons that are unsuited for any military purpose. It is the duty of artillery officers to develop the typical light draught horse required for artillery service, and it is in fulfillment of this duty that this book is written.

The author approaches his subject in a scientific spirit and discusses the history of the draught horse; the principles involved in drawing a carriage; the work of the motive power; effect of the conformation of the horse on its capacity to draw a load; influence of the speed of the horse on useful work performed; relation between speed of translation and weight of artillery carriages; selecting an artillery horse; training, feeding, and hygiene; and use of wheel vehicles in mountainous countries.

The text is well illustrated by pictures and drawings, and the book is free from the cant and mannerisms that disfigure so many books written about the horse.

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Monoposti o Biposti: Monoplani o Biplani. By Captain I. Gilbert de Winckels. Rome: Enrico Voghera. 6" x 9". 57 p. Paper. 1913.

The writer, apparently an experienced flier, examines at some length the requirements for a military aeroplane, and seeks to determine what type should be adopted. He concludes that no one type can be found to answer all purposes, any more than a navy can be reduced to one type of war vessel; but that two types, an "aeroplane of the line" and a "destroyer," will be sufficient.

His "aeroplane of the line" is a general purpose machine, useful both for observation and for attack of targets either in the air or on land. Being a weight carrier, and requiring free view downward, it is a biplane. Its armament includes an apparatus for dropping bombs, and an automatic gun; to permit free use of the latter, there is no front elevator and the screw is in rear. It is equipped with photographic apparatus, and appliances for signalling. The motor is provided with a muffler. Habitually the machine carries only the pilot; the writer claims that armament and other equipment have been devised that can be handled entirely from the pilot's seat, and that control mechanism is simple enough so that an experienced man will have time enough and hands enough to do everything necessary, either in reconnaissance or fighting. Since, however, it may sometimes be desirable to carry a special observer, a place is provided for a passenger.

The "destroyer" type is intended primarily for attacking the enemy's dirigibles or other air craft. It is built for speed—hence a monoplane carrying only the pilot. Its armament consists only of an automatic gun, to accommodate which the screw is in rear.

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Index to Current Military Literature

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1914

KEY

TO

INDEX TO CURRENT MILITARY LITERATURE

The periodicals cited are arranged by government, and each periodical is assigned a symbol consisting of an initial, or other abbreviation of the governmental designation, and a numeral indicative of the periodical's position in an alphabetical arrangement of the Journal of the United States Artillery's exchanges under that government.

Prices of subscription are given in the currencies of the countries of publication.

All the periodicals cited are preserved in the Library of the Coast Artillery School at Fort Monroe, Virginia.

ARGENTINE

Ar–0.5	*Anuario del Instituto Geografico Militar de la Republica Argentina* 3ª Division del Estado Mayor del Ejército Buenos Aires	Annual
Ar–1	*Boletin del Centro Naval* Florida 659, Buenos Aires	Bimonthly Per year $\$^{m}/_{n}$11.90
Ar–1.5	*Revista del Circulo Militar* 255 Maipu Buenos Aires	Monthly Per year $12.00
Ar–2	*Revista Militar* Ministerio de Guerra, Santa Fe 1461 Buenos Aires	Monthly Per year $\$^{m}/_{n}$9.00

AUSTRIA

Au–1	*Mitteilungen aus dem Gebiete des Seewesens* Pola	Monthly Per year 17 M
Au–2	*Mitteilungen ueber Gegenstaende des Artillerie-und Genie-Wesens* Getreidemarkt 9 Wien, VI.	Monthly Per year 20 M
Au–3	*Streffleurs Militaerische Zeitschrift zugleich Organ der militaerwissenschaftlichen Vereine* I. Graben, 13. Wien	Monthly Per year 28 M
Au–3.5	*Streffleurs Militarblatt* Verlag L. W. Seidel & Sohn, k.u.k Hofbuchhandler, Wien	Weekly Per year 16 M
Au–4	*Zeitschrift des Oesterreichischen Ingenieur und Architekten Vereines* I. Eschenbachgasse, No. 9 Wien	Weekly Per year 34 K

BELGIUM

Be–1	*Belgique Militaire, La* Rue Albert de Latour 50 Schaerbeck, Brussels	Weekly Per year 12 fr 50

Be–2	*Revue de l'Armée Belge*	Bimonthly
	24 Rue des Guillemins, Liege	Per year 13 fr
Be–3	*Revue de l'Ingénieur et Index Technique*	Quarterly
	70, Boulevard d'Anderlecht, Brussels	Per year 30 fr

BRAZIL

Br–1	*Boletim Mensal do Estado Maior do Exercito*	Monthly
	Ministerio de Guerra	
	Rio de Janeiro	
Br–2	*O Tiro*	Monthly
	Rio de Janeiro	
Br–3	*Revista Maritima Brazileira*	Monthly
	Rua D. Manoel n. 15	Per year 12$000
	Rio de Janeiro	

CHILE

C–1	*Memorial del Estado Mayor del Ejercito de Chile*	
	Talleres del Estado Mayor-General	Monthly
	Santiago	
C–2	*Revista de Marina*	Monthly
	Casilla del Correo 976, Valparaiso	Per year $15.00

COLOMBIA

Co–1	*Memorial del Estado Mayor del Ejercito de Colombia*	
	Jefe del Departamento de Historia del	
	Estado Mayor-General	Bimonthly
	Bogota	Per year $0 50 oro

DENMARK

D–0.5	*Dansk Artilleri-Tidsskrift*	Bimonthly
	Copenhagen	Per year 5 kr
D–1	*Militært Tidsskrift*	Semimonthly
	Copenhagen	Per year 8 kr

DOMINICAN REPUBLIC

DR–1	*El Porvenir Militar*	Monthly
	Salome Urena No. 8	
	Santo Domingo	

ECUADOR

E–1	*Boletin del Estado Mayor General*	Monthly
	Quito	Per year $4.00

FRANCE

F–1	*Archives Militaires, Les*	Quarterly
	Librairie Militaire Berger-Levrault	Per year 14 fr
	5-7 Rue des Beaux-Arts, Paris	
F–2	*France Militaire, La*	Daily
	10 Rue Danton, Paris	Per year 32 fr
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G–3.5	*Kriegstechnische Zeitschrift* E. S. Mittler & Sohn Königliche Hofbuchhandlung, Kochstrasse, 68-71, Berlin, S. W.	10 Nos. per yr. Per pear 10 M.
G–4	*Marine Rundschau* Koch Strasse, 68-71, Berlin, S.W.	Monthly Per year 10 M
G–5	*Militaer Wochenblatt* *With monthly Supplement* Koch Strasse, 68, Berlin, S.W., 12	3 times a week Per year 18 M
G–6	*Schiffbau* Zimmerstr. 9, Berlin, S.W., 68	Semimonthly Per year 20 M
G–8	*Ueberall* Verlag: Boll und Pickardt Berlin, N.W. 7	Monthly Per year 15.6 M

G-9	*Zeitschrift fuer das Gesamte Schiess-und Sprengstoffwesen* J. F. Lehmann's Verlag, Paul Heysestrasse 26, Munich	Semimonthly Per year 26 M

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I-2	*Rendiconti delle Esperienze e Degli Studi Eseguiti Nello Stabilimento di Esperienze e Costruzioni Aeronautiche del Genio* Viale Giulio Cesare N. 2, Rome	Occasional Per year 13.50 L
I-3	*Rivista di Artiglieria e Genio* Tipografia Enrico Voghera Via Astalli 15, Rome	Monthly, ex. July Per year 20 L
I-4	*Rivista Marittima* Officina Poligrafica Italiana Rome	Monthly Per year 25 L

MEXICO

M-1	*Boletin de Ingenieros* War Dept., Mexico City	Monthly
M-2	*Revista del Ejercito y Marina* Departamento de Estado Mayor City of Mexico	Monthly

NORWAY

N-1	*Norsk Artilleri-Tidsskrift* Christiania	Bimonthly Per year 6 kr
N-2	*Norsk Militært Tidsskrift* Christiania	Monthly Per year 8 kr

PERU

Pe-1	*Boletin del Ministerio de Guerra y Marina* Apartado de Correo No. 91, Lima	Fortnightly

PORTUGAL

Po-1	*Anais do Club Militar Naval* 43 Rua do Carmo, Lisbon	Monthly Per year 4$200
Po-2	*Revista de Artilharia* Rua do Carmo, 43, 2°., Direito, Lisbon	Monthly Per year 3$000 rs
Po-4	*Revista Militar* Largo da Annunciada, 9, Lisbon	Monthly Per year 3$000 rs

RUSSIA

R–1	*Imperial Nicholai War Academy Recorder, The* St. Petersburg	Monthly Per year 6 rubles
R–2	*News of the Officers' Artillery School* Zarskoye Selo	Monthly Per year 10 rubles

SPAIN

Sp–1	*Informacion Militar del Extranjero* Talleres del Deposito de la Guerra Madrid	Monthly
Sp–2	*Memorial de Artilleria* Museo de Artilleria, Madrid	Monthly Per year 18 ps
Sp–3	*Revista Cientifico-Militar* Paseo de San Juan, 201, Barcelona	Semimonthly Per year 40 ps
Sp–4	*Revista General de Marina* Ministerio de Marina, Madrid	Monthly Per year 25 ps

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UK–13	*Journal of the Royal United Service Institution* Whitehall, London, S.W.	Monthly Per year 24s
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US–29	*General Electric Review* General Electric Company Schenectady, New York	Monthly Per year $2.00
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US-48	*Official Gazette of the United States Patent Office, The* Supt. of Documents, Gov. Printing Office Washington, D. C.	Weekly Per year $5.00
US-49	*Pennsylvania Magazine of History and Biography* Philadelphia, Pa.	Quarterly Per year $3.00
US-50	*Physical Review* 41 North Queen Street, Lancaster, Pa.	Monthly Per year $6.00
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US-56	*Proceedings of the American Society of Civil Engineers* 220 West 57th Street New York	10 Nos. per year Per year $8.00
US-57	*Proceedings of The Engineers' Club of Philadelphia* 1317 Spruce Street Philadelphia, Pa.	Quarterly Per Vol. $2.00
US-58	*Proceedings of The Engineers' Society of Western Pennsylvania* 2511 Oliver Building Pittsburgh, Pa.	10 Nos. per year Per year $5.00
US-59	*Proceedings of the U. S. Naval Institute* Annapolis, Md.	Bimonthly Per year $3.00
US-60	*Professional Memoirs* Washington Barracks, D. C.	Bimonthly Per year $3.00
US-61	*Reactions* Goldschmidt Thermit Company 90 West Street, New York	Quarterly Per year $0.25
US-64	*Science Conspectus* Massachusetts Institute of Technology Boston, Mass.	Five issues per yr,
US-65	*Scientific American* 361 Broadway, New York	Weekly Per year $3.00

US–66L	*Scientific American Supplement* 361 Broadway, New York	Weekly Per year $5.00
US–68	*Seventh Regiment Gazette, The* 30 West 33rd Street, New York	Monthly Per year $1.50
US–71	*Stevens Indicator* Stevens Institute of Technology Hoboken, N. J.	Quarterly Per year $1.50
US–72	*Technical World Magazine* 5758 Drexel Avenue, Chicago, Ill.	Monthly Per year $1.50
US–73	*Telephone Engineer* Monadnock Building, Chicago, Ill.	Monthly Per year $2.00
US–74	*Transactions of the American Society of Civil Engineers* 220 West 57th Street, New York	Yearly Per year $12.00
US–75	*Transactions of the Society of Naval Architects and Marine Engineers* 29 West 39th Street, New York	Annual
US–76L	*Virginia Magazine of History and Biography, The* Virginia Historical Society Richmond, Va.	Quarterly Per year $5.00

SYNOPSIS OF SUBJECTS

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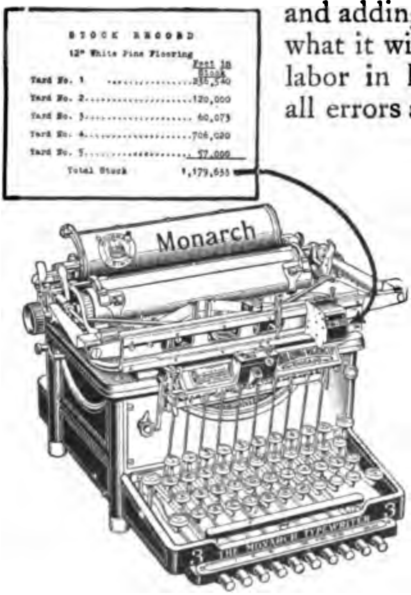
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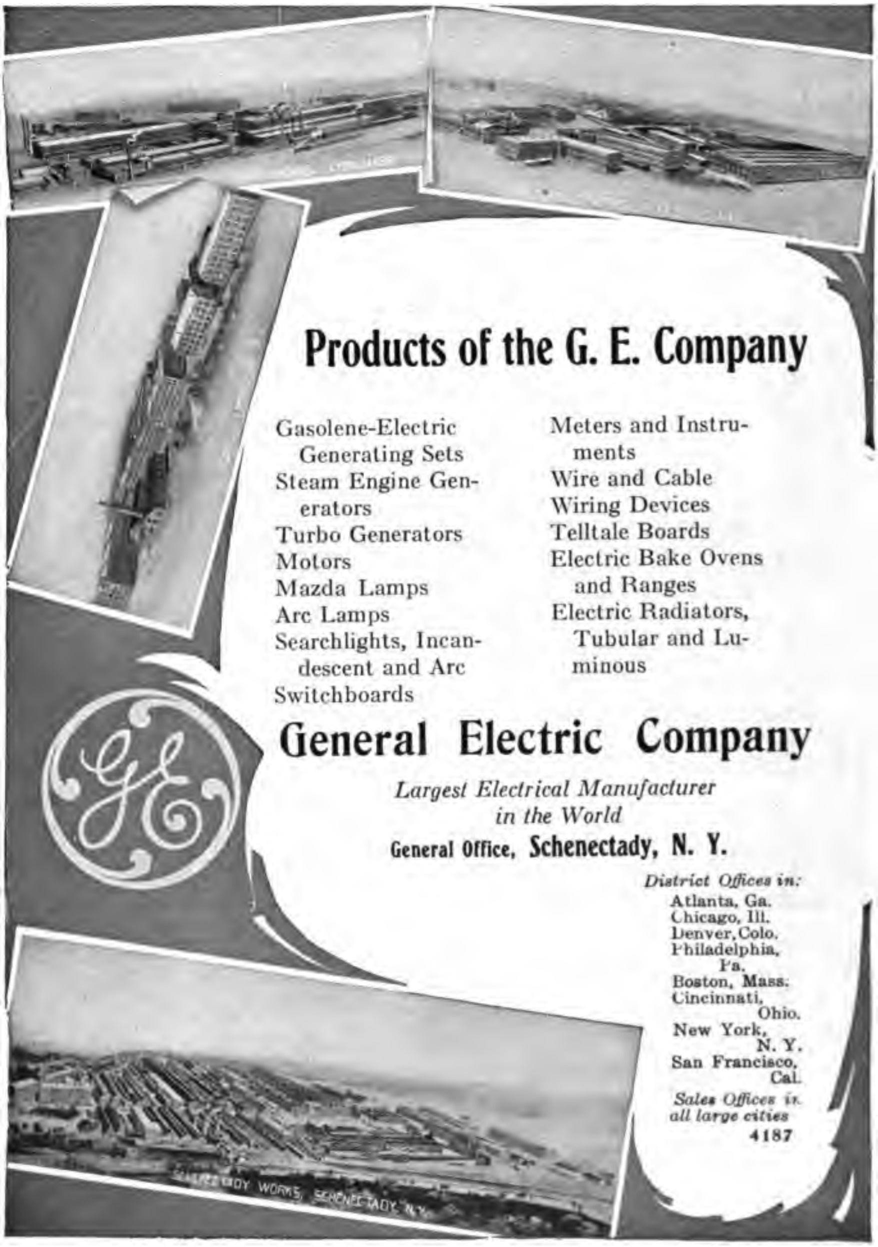

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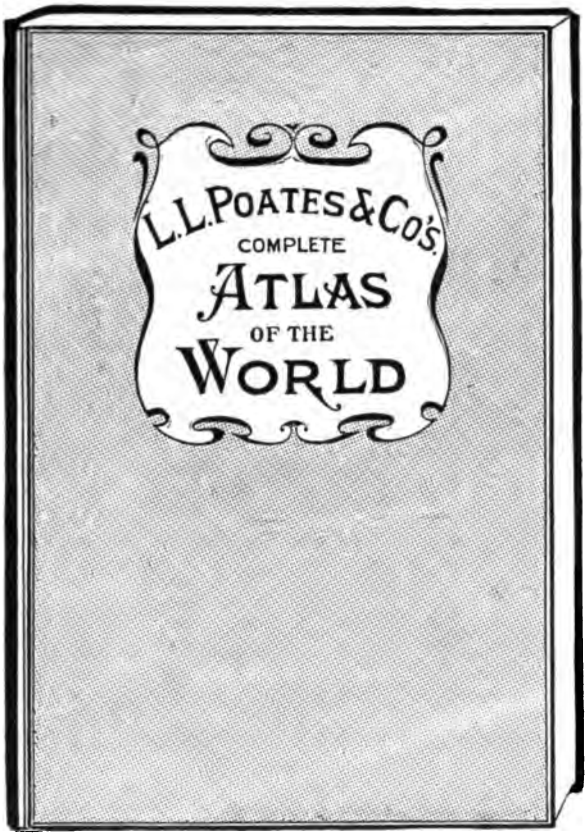

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